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CHAPTER I INTRODUCTION

A. STUDY AREA

The Truckee River originates at Lake Tahoe in eastern California, flows through the cities of Reno and Sparks in an easterly direction, and eventually drains into Pyramid Lake in northern Nevada. Steamboat Creek is the largest tributary to the Truckee River in the Reno area and enters the Truckee River near Vista. Evans and Dry creeks, two tributaries to Steamboat Creek, combine below Highway 395 to form Boynton Slough.

The study area for the project is divided into three portions: (1) the floodplain of the Truckee River between Booth Street and U.S. Highway 395 (Downtown Reno Reach); (2) the floodplain of the Truckee River from Highway 395 to Vista, along with the nearby floodplains of Steamboat Creek and Boynton Slough (Truckee Meadows Reach); and (3) the floodplain of the Truckee River between Vista and Pyramid Lake (Lower River Reach).

This report specifically addresses the bridges across the Truckee River within the Downtown Reno Reach between Booth Street and Highway 395 in Washoe County.

B. PROJECT OBJECTIVES

The Truckee Meadows area is subject to severe flooding from the Truckee River and its primary tributary, Steamboat Creek, during periods of high rainfall and snowmelt runoff. This project is investigating opportunities for flood damage reduction, ecosystem restoration and recreation. This report specifically addresses the flood damage reduction aspects of the project.

C. PURPOSE AND SCOPE

The existing bridges in the Downtown Reno Reach have not been evaluated in detail for stability (e.g., pier scour, over topping, uplift on the deck) for the with-project conditions with Risk and Uncertainty (R&U) increments. The purpose of this memorandum is to summarize previous evaluations of the Downtown Reno bridges and to recommend any additional analyses. The bridges discussed in this report include:

- Booth Street Bridge
- Keystone Avenue Bridge
- Arlington Avenue – North Bridge
- Arlington Avenue – South Bridge
- Sierra Street Bridge
- Virginia Street Bridge
- Lake Street Bridge
- East 2nd Street Bridge
- Kuenzli Bridge

This effort included a search of evaluations of existing bridges by the Corps, Nevada Department of Transportation (NDOT), City of Reno, Washoe County, A-E's and others. This summary

report documents available evaluations, their findings, criteria used in the evaluation, and recommendations for any additional analysis.

This work was conducted under contract #DACW05-01-0-0018, Delivery Order 7, Modification 1. This memorandum will provide information for other ongoing planning elements of the project.

D. PREVIOUS STUDIES AND PROJECTS

The Truckee Meadows Project was authorized for construction in the Water Resources Development Act (WRDA) of 1988 based on a 1985 Feasibility Report. During pre-construction, engineering, and design (PED), a reevaluation of project benefits and costs determined that the project, as then formulated, was no longer feasible due primarily to significant increases in land costs. A re-analysis was completed in a reconnaissance study completed in August 1997. The Corps reactivated the PED phase of the project in March 1998 with the first step to conduct a General Re-evaluation Report and EIS (GRR/EIS). At the request of the local sponsors, a Community Coalition process was initiated in April 2000 to assist in the formulation and selection of project alternatives.

Numerous studies have been completed that relate to environmental restoration, water use, hydrology, flooding, and urban development within the Reno/Sparks area and the Truckee River watershed. The recent analyses and studies pertinent to this report include the following:

Revised Draft Seepage Impact Memorandum, Truckee Meadows, Nevada. U.S. Army Corps of Engineers. January 2004.

Draft Real Estate Requirements, Downtown Reno Reach and Mustang Ranch Detention Facilities, Truckee Meadows, Nevada. U.S. Army Corps of Engineers. February 2003.

Flood Damage Reduction Alternatives Report Addressing Downtown Reno Bridges, Truckee Meadows, Nevada. U.S. Army Corps of Engineers. June 2002.

Design and Cost Estimates for Flood Damage Reduction, Downtown Reno Reach, Truckee Meadows, Nevada - Feasibility Report. U.S. Army Corps of Engineers. May 2000.

CHAPTER II EVALUATIONS OF BRIDGES UNDER EXISTING CONDITIONS

This chapter describes the evaluations completed for the Downtown Reno Reach bridges. These evaluations have been conducted under existing conditions and do not address modified hydraulic conditions under with-project conditions.

A. BACKGROUND ON BRIDGE EVALUATIONS AND ANALYSES

1. National Bridge Inventory Data and Structure Inspections Reports

National Bridge Inventory data and Structure Inspection Reports were obtained for each of the nine Downtown Reno Bridges from the Nevada Department of Transportation and are provide in **Attachment 1**. These evaluations were completed in 2002 for the Federal Highway Administration (FHWA) National Bridge Inspection Program (NBIS). These evaluations were performed according to FHWA's *Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges*. A summary of these evaluations is provided for each bridge in the following section.

The inventory data sheet provides a physical description of the bridge and includes other information such as average daily traffic, detour length, defense highway designation, etc. The inspection reports are a condition assessment of the bridge. The inventory data sheet includes a Sufficiency Rating. Both inventory and inspection data are used to determine the Sufficiency Rating. The Sufficiency Rating is derived from a numerical formula that includes inventory data and the condition assessment inspections.

The Sufficiency Rating can vary from 0 to 100. 100 represents a bridge with no deficiencies and 0 represents a completely insufficient bridge. A bridge must have a Sufficiency Rating less than 50 and be either functionally obsolete or structurally deficient to be eligible for replacement. A bridge must have a Sufficiency Rating less than 80 and be either functionally obsolete or structurally deficient to be eligible for rehabilitation. A bridge is structurally deficient when key elements of a bridge are in a severe state of deterioration. A bridge is functionally obsolete when it does not adequately serve the road it carries. Examples of functionally obsolete bridges include a single lane bridge on a two-lane road, substandard under-clearance, or a weight restriction.

2. Scour Analysis Reports

Scour analysis reports were obtained for eight of the nine Downtown Reno Reach bridges and are provided in **Attachment 2**. The eight the scour analysis reports were completed immediately after January 1997 flood event. Per personal communications with Chris Miller with NDOT these are the most recent detailed scour analyses. A summary of these scour analysis reports is provided for each bridge in the following section. The scour analysis for each bridge was performed in compliance with the FHWA Technical Advisory T5140.23, *Evaluating Scour at Bridges*. The methodology used for the eight scour reports is described below.

Hydrology and Hydraulics

FHWA mandates that the peak discharge used in scour evaluations is to be the lesser of either the 500-year discharge or the overtopping flow. Each bridge was evaluated at a specific flow rate, and with the exception of the Keystone Avenue Bridge, all bridges were evaluated for scour at their respective overtopping flow. The overtopping flows for the bridges ranged from 8,330 cfs to 35,277 cfs. For the scour analyses, overtopping flows were determined by at trial and error process utilizing the Corp water surface profile program HEC-RAS, Version 1.1. The Keystone Bridge was evaluated with an estimated 500-year event of 52,500 cfs. Hydraulic parameters such as velocity and flow depth were determined from the HEC-RAS simulations.

Long-Term Channel Stability

The geomorphic assessments of the bridges were based on field investigations and the Desert Research Institute document *Regional, Long-Term/Assessment of Channel Stability along the Truckee River, Nevada, from Verdi to Pyramid Lake: Implications to the Potential for Catastrophic Bridge Failure*. The Truckee River Channel alignment was considered stable in the vicinity of the eight Downtown Reno bridges.

Local Scour (Contraction, Pier, Abutment)

Local bridge scour calculations were performed using the procedures of the FHWA Hydraulic Engineering Circular No. 18, *Evaluating Scour at Bridges*. The hydraulic input data used in the scour equations were determined using HEC-RAS, and included flow depth, maximum velocity, Froude number, channel flow width and discharge (main channel and overbank). Other input data consisted of pier shape, flow angle of attack and channel bed condition.

When applicable, pier scour calculations were conducted using the greatest channel velocity and corresponding depth, skew angle adjustments and a uniformly placed 4 foot debris with at each pier as defined in the *Scour Study Project Field Guide*.

Contraction scour calculations were based on the critical transport threshold velocity for the D50 sediment size and the hydraulic depth. Critical transport velocities were determined for each bridge approach section using the hydraulic depth (area/top width).

Due to the unreliable nature of the HEC-18 abutment scour equations, abutment scour depths were neither calculated nor included in the total cumulative scour estimates. Instead a qualitative assessment of abutment scour vulnerability was made based on site inspection and flood damage history.

B. SUMMARY OF PREVIOUS EVALAUTIONS ON DOWNTOWN RENO BRIDGES

1. Booth Street Bridge

The Booth Street Bridge was built in 1994, replacing the previous structure that was constructed in 1920. The bridge, as shown in **Photo 1**, is approximately 128 feet in length and 54 feet in width. The bridge deck slopes from south to north at about 2.6%. The deck carries two-way traffic (one lane each way) and includes a pedestrian sidewalk on each side. The bridge was inspected and evaluated as part of the National Bridge Inventory in 2002. As shown in **Table 1**, Booth Street Bridge received a Sufficiency Rating of 96.7 with all items considered to be in good or very good condition.

The Booth Street bridge was the only bridge in the Downtown Area for which a Scour Analysis Report was not prepared. No scour evaluation report was completed for the bridge because it was relatively new and was designed to withstand expected existing conditions scour. However, hydraulic design information was obtained from Chris Miller, NDOT. Information received included one preliminary design drawing, HEC-2 output, hand written design notes, and various meeting notes. Based on information received, the bridge was designed to pass a 12,500 cfs (50-year event) with a minimum of 6 inches of freeboard. During the design of the new structure, a scour analysis was completed in 1991 using the computer program HY 9 which is based on the HEC No. 18, *Evaluating Scour at Bridges*. Estimates of the 100-year and 500-year events, 18,500 cfs and 31,450 cfs, respectively, were evaluated.

Other information regarding scour at the Booth Street Bridge included the *Nevada Department of Transportation; National Bridge Inventory/Structure Inspection Report for B1621*. This report provided a Scour Vulnerability Rating (Item 113) of an 8. A rating of 8 is identified as “bridge foundations determined to be stable for calculated scour conditions; calculated scour is above top of footing”. However, based on personal communication with Glen Daily with the City of Reno, scour was an issue during the 1997 flood event. The NDOT completed repairs at this site following the flood.

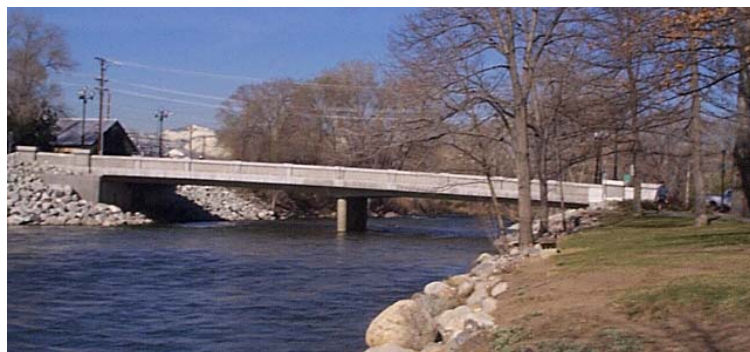


Photo 1

Photo looking west at downstream face of Booth Street Bridge.

TABLE 1
SUMMARY OF NATIONAL BRIDGE INVENTORY/STRUCTURE INSPECTION
REPORT FOR BOOTH STREET BRIDGE

Summary of Condition Items					
NBI Code #	Condition Items	Score	Score Description	Range of Element Scores	
				Low	High
58	Deck	8	Very Good Condition	6	8
59	Superstructure	7	Good Condition	7	8
60	Substructure	8	Very Good Condition	7	8
61	Channel and Protection	7	Good Condition	7	8
Summary of Appraisal Items					
NBI Code #	Appraisal Items	Score	Score Description		
67	Structural Evaluation	7	Better than present minimum criteria		
68	Deck Geometry	6	Equal to present minimum criteria		
69	Structural Underclearance	N	Not Applicable		
71	Waterway Adequacy	8	Equal to present desirable criteria		
72	Approach Alignment	6	Equal to present minimum criteria		
Findings and Recommendations					
Key Comments in Maintenance Report		Minor maintenance recommendations			
Sufficiency Rating		96.7			
Source: Nevada Department of Transportation; National Bridge Inventory/Structure Inspection Report for B1621, 01 April 2002					

2. Keystone Bridge

The Keystone Avenue Bridge, shown in **Photo 2**, was constructed in 1966. This structure is a four-span shallow arch bridge with piers and abutments supported by footings. The bridge is approximately 400 feet in length and 56 feet in width. The deck carries two-way traffic (two lanes each way) with no pedestrian sidewalks.

Information obtained for the Keystone Avenue Bridge included a Scour Analysis Report, National Bridge Inventory/Structure Inspection Report, and various design drawings. The bridge was inspected and evaluated as part of the National Bridge Inventory in 2002. As shown in **Table 2**, Keystone Avenue Bridge received a Sufficiency Rating of 49.3 and is considered structurally deficient. Following the January 1997 flood, the NDOT conducted a scour analysis of the bridge. The bridge is considered “scour critical”, as shown in **Table 3**. A portion of the design drawings, 17 sheets, for the bridge were also obtained.



Photo 2
Photo looking north at Keystone Avenue Bridge during 1997 flood event.

TABLE 2
SUMMARY OF NATIONAL BRIDGE INVENTORY/STRUCTURE INSPECTION
REPORT FOR KEYSTONE AVENUE BRIDGE

Summary of Condition Items					
NBI Code #	Condition Items	Score	Score Description	Range of Element Scores	
				Low	High
58	Deck	7	Good Condition	3	8
59	Superstructure	6	Satisfactory Condition	3	7
60	Substructure	4	Poor Condition	3	7
61	Channel and Protection	7	Good Condition	7	8
Summary of Appraisal Items					
NBI Code #	Appraisal Items	Score	Score Description		
67	Structural Evaluation	4	Meets minimum tolerable limits to be left in place as is		
68	Deck Geometry	7	Better than present minimum criteria		
69	Structural Underclearance	N	Not Applicable		
71	Waterway Adequacy	9	Superior to present desirable criteria		
72	Approach Alignment	7	Better than present minimum criteria		
Findings and Recommendations					
Key Comments in Maintenance Report		Patch spalls and provide new fine surface finish to concrete parapet. Seal cracks in façade and repair façade blocks in spans 2 and 4. Blast and repaint girders and diaphragms. Patch spalls and inject cracks in wingwalls and breast walls. Rehabilitate pier caps.			
Sufficiency Rating		49.3 – STRUCTURALLY DEFICIENT			
Source: Nevada Department of Transportation; National Bridge Inventory/Structure Inspection Report for B1530, 02 April 2002					

TABLE 3
SUMMARY OF KEYSTONE AVENUE BRIDGE SCOUR ANALYSIS

Data Category	Report Findings
Report Title	Scour Analysis Report – Bridge No. B-1530 February 1997
Hydrology ⁽¹⁾	52,500 cfs; 500 year event. Since construction in 1975, the structure has not experienced any large flows that approach the evaluation discharge. The largest event was the 1997 flood event that was less than 50% of the evaluation discharge.
Scour Analyses ⁽²⁾ Thalweg Elevation Footing Foundation Elevation Local Scour Depth Contract Scour Long Term Bottom Scour Hole Elevation	4491.47 ft MSL 4487.0 ft MSL 11.75 ft 0.0 ft 0.0 ft 4479.72 ft MSL
Local Scour	The local scour exceeded the bottom footing elevation by approximately 7.5 feet. Although the bridge piers prone to scour are not directly in the main channel, a slight shift in the thalweg could make either susceptible to pier scour, particularly if the channel shifted towards the left bank.
Contraction Scour	Contraction scour is not anticipated.
Long Term Scour	In the vicinity of structure B-1530, the Truckee River channel alignment is considered stable. The long term scour assessment was determined to be 0.0 feet.
Abutment Scour	Abutment scour does not appear to be possible along the left abutment due to the presence of concrete paving and the considerable setback distance from the core of the channel flow distribution. Based on HEC-18 calculations, the riprap adjacent to the right abutment is undersized by 146 percent. Thus, the right abutment is at risk of failing based on the flow used in the evaluation
Scour Vulnerability Rating ⁽²⁾	3 – Bridge is scour critical; bridge foundations determined to be unstable for calculated scour; scour below spread footing base or pile tips. A value of 3 was assigned because of the estimated depth of scour was large enough to place the scour hole below the footing and thus make the bridge scour critical. A more severe rating (such as a 2, 1, or 0) was not assigned because the field review did not observe extensive scour nor imminent failure of piers/abutments
Report Findings	The report assessed that that the Scour Vulnerability Rating of 3 represented an appropriate level of risk for the bridge. The report concluded that the structure is currently at risk of failure from scour.
<p><i>(1) – FHWA mandates the peak flow to be used in scour evaluations is to be the lesser of either the 500-year peak flow or the overtopping flow.</i></p> <p><i>(2)– Scour analyses performed using procedures from FHWA Hydraulic Engineering Circular No. 18, Evaluating Scour at Bridges (FHWA HEC - 18 Third Edition). Scour Vulnerability Rating based on National Bridge Inventory Item 113 code. Hydraulic Input data determined from HEC-RAS Version 1.1.</i></p>	

3. Arlington Avenue – North Bridge

Arlington Avenue spans the Truckee River via two bridges, denoted as Arlington Avenue – North Bridge and Arlington Avenue - South Bridge. The Arlington Avenue - North Bridge, shown in **Photo 3**, is a three-span shallow arch bridge with piers and abutments supported by footings. The bridge deck carries two way traffic, a turning lane for north bound traffic, and two pedestrian sidewalks. The bridge is approximately 120 feet in length and 60 feet in width.

Information obtained for the Arlington Avenue – North Bridge included a Scour Analysis Report, National Bridge Inventory/Structure Inspection Report and various design drawings. The bridge was inspected and evaluated as part of the National Bridge Inventory in 2002. As shown in **Table 4**, Arlington Avenue – North Bridge received a Sufficiency Rating of 81.3. Following the January 1997 flood, the NDOT conducted a scour analysis of the bridge. The bridge is considered “scour critical”, as shown in **Table 5**. Based on personal communication with Bill Crawford, NDOT, and Glen Daily, City of Reno, significant scour was observed after the 1997 flood event. The original piers were completely undermined. The NDOT completed repairs at this site following the flood.

Other information obtained regarding the bridge includes two sets of design drawings. The first set of design drawings was for the bridge widening that was completed in 1938-1939. The second set of design drawings was for the bridge widening that was completed in 1966.



Photo 3

Photo looking east at upstream face of Arlington Avenue - North Bridge (Note photo taken prior to construction of Reno Whitewater Park).

TABLE 4
SUMMARY OF NATIONAL BRIDGE INVENTORY/STRUCTURE INSPECTION
REPORT FOR ARLINGTON AVENUE - NORTH BRIDGE

Summary of Condition Items					
NBI Code #	Condition Items	Score	Score Description	Range of Element Scores	
				Low	High
58	Deck	5	Fair Condition	3	7
59	Superstructure	5	Fair Condition	4	7
60	Substructure	5	Fair Condition	4	8
61	Channel and Protection	7	Good Condition	6	7
Summary of Appraisal Items					
NBI Code #	Appraisal Items	Score	Score Description		
67	Structural Evaluation	5	Somewhat better than minimum adequacy to tolerate being left in place as is		
68	Deck Geometry	9	Superior to present desirable criteria		
69	Structural Underclearance	N	Not Applicable		
71	Waterway Adequacy	6	Equal to present minimum criteria		
72	Approach Alignment	8	Equal to present desirable criteria		
Findings and Recommendations					
Key Comments in Maintenance Report		Widespread significant deterioration. Warrants structural analysis and probable rehabilitation/replacement of deck, superstructure, and substructure elements. Minor interim repairs. Otherwise defer maintenance until rehabilitation or replacement.			
Sufficiency Rating		81.3			
Source: Nevada Department of Transportation; National Bridge Inventory/Structure Inspection Report for B1532, 03 April 2002					

TABLE 5
SUMMARY OF ARLINGTON AVENUE - NORTH BRIDGE SCOUR ANALYSIS

Data Category	Report Findings
Report Title	Scour Analysis Report – Bridge No. B-1532 February 1997
Hydrology ⁽¹⁾	12,719 cfs; overtopping flow. (split between the two Arlington Avenue bridges) The structure has seen flows in excess of the of the evaluation discharge 6 times over a 47 year period.
Scour Analyses ⁽²⁾ Thalweg Elevation Footing Foundation Elevation Local Scour Depth Contract Scour Long Term Bottom Scour Hole Elevation	4481.0 ft MSL 4476.0 ft MSL 8.96 ft 0.0 ft 0.0 ft 4472.04 ft MSL
Local Scour	The local scour exceeded the bottom footing elevation by approximately 3.8 feet. The footing is supported by channel material and the HEC-18 analysis indicated scour would occur, leaving the pier unsupported. These evaluations did not reflect the effect of pressure flow. Pressure flow could substantially increase the scour depths for flows greater than the event used in this analysis.
Contraction Scour	Contraction scour is not anticipated.
Long Term Scour	In the vicinity of structure B-1532, the Truckee River channel alignment is considered stable. The long term scour assessment was determined to be 0.0 feet.
Abutment Scour	Abutment scour is not possible on both abutments upstream of the structure and downstream of the structure on the left bank due to the existence of river walls. However if these walls were to fail or be undermined, the abutments could be at risk. Additionally, the right bank on the downstream side of the bridge is unprotected.
Scour Vulnerability Rating ⁽²⁾	3 – Bridge is scour critical; bridge foundations determined to be unstable for calculated scour; scour below spread footing base or pile tips. A value of 3 was assigned because of the estimated depth of scour was large enough to place the scour hole below the footing and thus make the bridge scour critical. A more severe rating (such as a 2, 1, or 0) was not assigned because the field review did not observe extensive scour nor imminent failure of piers/abutments
Report Findings	Although the scour vulnerability rating was a 3, the report concluded that this rating may not represent an appropriate level of risk for the bridge. Considering field and office evaluations, the report assessed that the structure is not currently at significant risk of failure from scour.
<i>(1) – FHWA mandates the peak flow to be used in scour evaluations is to be the lesser of either the 500-year peak flow or the overtopping flow.</i> <i>(2)– Scour analyses performed using procedures from FHWA Hydraulic Engineering Circular No. 18, Evaluating Scour at Bridges (FHWA HEC - 18 Third Edition). Scour Vulnerability Rating based on National Bridge Inventory Item 113 code. Hydraulic Input data determined from HEC-RAS Version 1.1.</i>	

4. Arlington Avenue – South Bridge

The South Arlington Avenue Bridge, shown in **Photo 4**, is a single span shallow arch bridge with abutments supported by footings. The deck carries two way traffic and two pedestrian sidewalks. The bridge is approximately 50 feet in length and 60 feet in width.

Information obtained for the Arlington Avenue – South Bridge included a Scour Analysis Report, National Bridge Inventory/Structure Inspection Report and various design drawings. The bridge was inspected and evaluated as part of the National Bridge Inventory in 2002. As shown in **Table 6**, Arlington Avenue – South Bridge received a Sufficiency Rating of 62.1 and is considered structurally deficient. Following the January 1997 flood, the NDOT conducted a scour analysis of the bridge. The bridge foundations are considered stable with respect to scour, as shown in **Table 7**. Other information obtained regarding the bridge included a set of design drawings. This set of design drawings was for the bridge widening that was completed in 1966.



Photo 4

Photo looking east at upstream face of Arlington Avenue - South Bridge (Note photo taken prior to construction of Reno Whitewater Park).

TABLE 6
SUMMARY OF NATIONAL BRIDGE INVENTORY/STRUCTURE INSPECTION
REPORT FOR ARLINGTON AVENUE - SOUTH BRIDGE

Summary of Condition Items					
NBI Code #	Condition Items	Score	Score Description	Range of Element Scores	
				Low	High
58	Deck	5	Fair Condition	4	7
59	Superstructure	5	Fair Condition	3	7
60	Substructure	5	Fair Condition	6	8
61	Channel and Protection	7	Good Condition	5	8
Summary of Appraisal Items					
NBI Code #	Appraisal Items	Score	Score Description		
67	Structural Evaluation	4	Meets minimum tolerable limits to be left in place as is		
68	Deck Geometry	9	Superior to present desirable criteria		
69	Structural Underclearance	N	Not Applicable		
71	Waterway Adequacy	6	Equal to present minimum criteria		
72	Approach Alignment	8	Equal to present desirable criteria		
Findings and Recommendations					
Key Comments in Maintenance Report		Rehabilitate deck overhangs, arch superstructure, and parapets. Repair abutments and wingwalls. Monitor bridge during periods of flooding.			
Sufficiency Rating		62.1 – STRUCTURALLY DEFICIENT			
Source: Nevada Department of Transportation; National Bridge Inventory/Structure Inspection Report for B1531, 03 April 2002					

TABLE 7
SUMMARY OF ARLINGTON AVENUE - SOUTH BRIDGE SCOUR ANALYSIS

Data Category	Report Findings
Report Title	Scour Analysis Report – Bridge No. B-1531 February 1997
Hydrology ⁽¹⁾	11,823 cfs; overtopping flow. (split between the two Arlington Avenue bridges) The structure has seen flows in excess of the of the evaluation discharge 6 times over a 47 year period.
Scour Analyses ⁽²⁾ Thalweg Elevation Footing Foundation Elevation Local Scour Depth Contract Scour Long Term Bottom Scour Hole Elevation	4481.0 ft MSL 4474.70 ft MSL (Abutment) 0 ft 0.0 ft 0.0 ft 4481.0 ft MSL
Local Scour	Since this is a single span bridge, there are no piers and consequently there is no local scour.
Contraction Scour	Contraction scour is not anticipated.
Long Term Scour	In the vicinity of structure B-1531, the Truckee River channel alignment is considered stable. The long term scour assessment was determined to be 0.0 feet.
Abutment Scour	From field observations both bridge abutments appeared to be stable and not at risk of instability.
Scour Vulnerability Rating ⁽²⁾	5 – Bridge foundations determined to be stable for calculated scour conditions; sour within limits of footings or piles. A value of 5 was assigned because the estimated depth of scour placed the resulting channel invert elevation well above the nearest bridge footing. A more severe rating (such as 4) was not assigned because the field review did not observe exposed foundations resulting from the effects of additional erosion.
Report Findings	The report concluded that the structure was not at unusual risk of failure from scour.
<i>(1) – FHWA mandates the peak flow to be used in scour evaluations is to be the lesser of either the 500-year peak flow or the overtopping flow.</i> <i>(2)– Scour analyses performed using procedures from FHWA Hydraulic Engineering Circular No. 18, Evaluating Scour at Bridges (FHWA HEC - 18 Third Edition). Scour Vulnerability Rating based on National Bridge Inventory Item 113 code. Hydraulic Input data determined from HEC-RAS Version 1.1.</i>	

5. Sierra Street Bridge

The existing Sierra Street Bridge, as shown in **Photo 5**, consists of a skewed concrete deck supported by three spans of continuous steel girders. The bridge was built in 1937. The existing deck is approximately 135 feet long and 62 feet wide and is supported by two intermediate piers. The deck carries one-way traffic in three lanes with a single parallel parking strip on the upstream and pedestrian sidewalks on each side of the bridge.

Information obtained for the Sierra Street Bridge included a Scour Analysis Report, National Bridge Inventory/Structure Inspection Report and various design drawings. The bridge was inspected and evaluated as part of the National Bridge Inventory in 2002. As shown in **Table 8**, Sierra Street Bridge received a Sufficiency Rating of 54.6 and is considered structurally deficient. Following the January 1997 flood, the NDOT conducted a scour analysis of the

bridge. The bridge is considered “scour critical” with respect to scour, as shown in **Table 9**. Based on personal communication with Bill Crawford, NDOT, and Glen Daily, City of Reno, scour and undermining was observed along the south abutment and retaining walls after the 1997 flood event. The NDOT completed repairs at this site following the flood. No design drawings were obtained for the bridge.



Photo 5

Photo looking east at upstream face of Sierra Street Bridge.

TABLE 8
SUMMARY OF NATIONAL BRIDGE INVENTORY/STRUCTURE INSPECTION
REPORT FOR SIERRA STREET BRIDGE

Summary of Condition Items					
NBI Code #	Condition Items	Score	Score Description	Range of Element Scores	
				Low	High
58	Deck	4	Poor Condition	3	7
59	Superstructure	5	Fair Condition	4	7
60	Substructure	4	Poor Condition	2	7
61	Channel and Protection	4	Poor Condition	4	8
Summary of Appraisal Items					
NBI Code #	Appraisal Items	Score	Score Description		
67	Structural Evaluation	4	Meets minimum tolerable limits to be left in place as is		
68	Deck Geometry	9	Superior to present desirable criteria		
69	Structural Underclearance	N	Not Applicable		
71	Waterway Adequacy	6	Equal to present minimum criteria		
72	Approach Alignment	8	Equal to present desirable criteria		
Findings and Recommendations					
Key Comments in Maintenance Report		Provide new deck wearing surface, at which time the expansion joints should be exposed and inspected for probable repair/replacement. Rehabilitate deck. Repair bridge railing, sidewalks, parapets, abutments, pier walls. Repair deck/beam separations. Replace missing diaphragm rivet. Repair scour at south abutment.			
Sufficiency Rating		54.6 – STRUCTURALLY DEFICIENT			
Source: Nevada Department of Transportation; National Bridge Inventory/Structure Inspection Report for B303, 05 April 2002					

TABLE 9
SUMMARY OF SIERRA STREET BRIDGE SCOUR ANALYSIS

Data Category	Report Findings
Report Title	Scour Analysis Report – Bridge No. B-303 February 1997
Hydrology ⁽¹⁾	11,845 cfs; overtopping flow. The structure has seen flows in excess of the of the evaluation discharge 5 times since its construction in 1936.
Scour Analyses ⁽²⁾	
Thalweg Elevation	4475.44 ft MSL
Footing Foundation Elevation	4470.9 ft MSL
Local Scour Depth	10.32 ft
Contract Scour	0.0 ft
Long Term	0.0 ft
Bottom Scour Hole Elevation	4465.12 ft MSL
Local Scour	The local scour exceeded the bottom footing elevation by approximately 5.8 feet. The footing is supported by channel material and the HEC-18 analysis indicated scour would occur, leaving the pier unsupported. These evaluations did not reflect the effect of pressure flow. Pressure flow could substantially increase the scour depths for flows greater than the event used in this analysis.
Contraction Scour	Contraction scour is not anticipated.
Long Term Scour	In the vicinity of structure B-303, the Truckee River channel alignment is considered stable. The long term scour assessment was determined to be 0.0 feet.
Abutment Scour	Abutment scour is not possible due to the existence of river walls. However if these walls were to fail or be undermined, the abutments could be at risk.
Scour Vulnerability Rating ⁽²⁾	3 – Bridge is scour critical; bridge foundations determined to be unstable for calculated scour; scour below spread footing base or pile tips. A value of 3 was assigned because of the estimated depth of scour was large enough to place the scour hole below the footing and thus make the bridge scour critical. A more severe rating (such as a 2, 1, or 0) was not assigned because the field review did not observe extensive scour nor imminent failure of piers/abutments
Report Findings	The report assessed that that the Scour Vulnerability Rating of 3 represented an appropriate level of risk for the bridge. The report concluded that the structure is currently at risk of failure from scour.
<i>(1) – FHWA mandates the peak flow to be used in scour evaluations is to be the lesser of either the 500-year peak flow or the overtopping flow.</i> <i>(2)– Scour analyses performed using procedures from FHWA Hydraulic Engineering Circular No. 18, Evaluating Scour at Bridges (FHWA HEC - 18 Third Edition). Scour Vulnerability Rating based on National Bridge Inventory Item 113 code. Hydraulic Input data determined from HEC-RAS Version 1.1.</i>	

6. Virginia Street Bridge

The existing Virginia Street Bridge, as shown in **Photo 6**, consists of a concrete deck supported by a two-span concrete arch. The deck is 146 feet long and 80 feet wide supported by two elliptical arches. Each arch has a clear span of approximately 60.5 feet and a rise of 10.8 feet from the spring line to the intrados. The deck presently accommodates four lanes of traffic (two each way) with parallel parking strips and sidewalks on each side.

A plaque mounted on the bridge indicates that construction commenced on July 17, 1905 and that the bridge was opened to traffic four months later on November 12, 1905. The Virginia

Street Bridge, the oldest in Nevada, was declared “Historical” because of its historical and technical value, and has been on the National Register of Historic Places since 1980.

Information obtained for the Virginia Street Bridge included a Scour Analysis Report, National Bridge Inventory/Structure Inspection Report and various design drawings. The bridge was inspected and evaluated as part of the National Bridge Inventory in 2002. As shown in **Table 10**, the Virginia Street Bridge received a Sufficiency Rating of 2 and is considered structurally deficient. Following the January 1997 flood, the NDOT conducted a scour analysis of the bridge. The bridge is considered “scour critical”, as shown in **Table 11**. Other information obtained regarding the bridge included an architectural drawing of the bridge and a design sheet that is believed to be one of the original (i.e. 1905) design drawings.



Photo 6

Photo looking east at upstream face of Virginia Street Bridge.

TABLE 10
SUMMARY OF NATIONAL BRIDGE INVENTORY/STRUCTURE INSPECTION
REPORT FOR VIRGINIA STREET BRIDGE

Summary of Condition Items					
NBI Code #	Condition Items	Score	Score Description	Range of Element Scores	
				Low	High
58	Deck	3	Serious Condition	2	7
59	Superstructure	2	Critical Condition	2	8
60	Substructure	2	Critical Condition	2	7
61	Channel and Protection	6	Satisfactory Condition	6	7
Summary of Appraisal Items					
NBI Code #	Appraisal Items	Score	Score Description		
67	Structural Evaluation	2	Basically intolerable requiring high priority of replacement		
68	Deck Geometry	7	Better than present minimum criteria		
69	Structural Underclearance	N	Not Applicable		
71	Waterway Adequacy	3	Basically intolerable requiring high priority of corrective action		
72	Approach Alignment	8	Equal to present desirable criteria		
Findings and Recommendations					
Key Comments in Maintenance Report		Monitor structure deterioration and scour on interim and diving inspections until bridge is rehabilitated. Structure should also be monitored for scour-related problems after periods of high flow.			
Sufficiency Rating		2 – STRUCTURALLY DEFICIENT			
Source: Nevada Department of Transportation; National Bridge Inventory/Structure Inspection Report for, 09 October 2002					

TABLE 11
SUMMARY OF VIRGINIA STREET BRIDGE SCOUR ANALYSIS

Data Category	Report Findings
Report Title	Scour Analysis Report – Bridge No. B-178 February 1997
Hydrology ⁽¹⁾	12,265 cfs; overtopping flow. The structure has seen flows in excess of the of the evaluation discharge 6 times since its construction in 1905.
Scour Analyses ⁽²⁾	
Thalweg Elevation	4474.0 ft MSL
Footing Foundation Elevation	4468.4 ft MSL
Local Scour Depth	16.32 ft
Contract Scour	0.0 ft
Long Term	0.0 ft
Bottom Scour Hole Elevation	4457.68 ft MSL
Local Scour	The local scour exceeded the bottom footing elevation by approximately 10 feet. The footing is supported by channel material and the HEC-18 analysis indicated scour would occur, leaving the pier unsupported. These evaluations did not reflect the effect of pressure flow. Pressure flow could substantially increase the scour depths for flows greater than the event used in this analysis.
Contraction Scour	Contraction scour is not anticipated.
Long Term Scour	In the vicinity of structure B-178, the Truckee River channel alignment is considered stable. The long term scour assessment was determined to be 0.0 feet.
Abutment Scour	Abutment scour is not possible due to the existence of river walls. However if these walls were to fail or be undermined, the abutments could be at risk.
Scour Vulnerability Rating ⁽²⁾	3 – Bridge is scour critical; bridge foundations determined to be unstable for calculated scour; scour below spread footing base or pile tips. A value of 3 was assigned because of the estimated depth of scour was large enough to place the scour hole below the footing and thus make the bridge scour critical. A more severe rating (such as a 2, 1, or 0) was not assigned because the field review did not observe extensive scour nor imminent failure of piers/abutments
Report Findings	The report assessed that that the Scour Vulnerability Rating of 3 represented an appropriate level of risk for the bridge. The report concluded that the structure is currently at risk of failure from scour.
<i>(1) – FHWA mandates the peak flow to be used in scour evaluations is to be the lesser of either the 500-year peak flow or the overtopping flow.</i> <i>(2)– Scour analyses performed using procedures from FHWA Hydraulic Engineering Circular No. 18, Evaluating Scour at Bridges (FHWA HEC - 18 Third Edition). Scour Vulnerability Rating based on National Bridge Inventory Item 113 code. Hydraulic Input data determined from HEC-RAS Version 1.1.</i>	

7. Lake Street Bridge

The existing Lake Street Bridge, as shown in **Photo 7**, is a three-span continuous concrete “tee beam” type bridge. The bridge was built in 1937. The deck is 176 feet long and 60 feet wide and is supported by “U” shaped abutments and two intermediate piers. The bottom chord of each span displays a parabolic curvature with a 2-foot 8-inch rise at mid-span. The deck carries two-way traffic (one lane each way) and has a parallel parking strip and pedestrian sidewalks on each side.

Information obtained for the Lake Street Bridge included a Scour Analysis Report, National Bridge Inventory/Structure Inspection Report and various design drawings. The bridge was inspected and evaluated as part of the National Bridge Inventory in 2002. As shown in **Table 12**, Lake Street Bridge received a Sufficiency Rating of 79.2, but is considered Functionally Obsolete. Following the January 1997 flood, the NDOT conducted a scour analysis of the bridge. The bridge is considered “scour critical”, as shown in **Table 13**. Other information obtained regarding the bridge included miscellaneous drawings from the replacement of the railings after the 1997 flood. Based on personal communication with Bill Crawford, NDOT, the foundations of the structure are believed to be shallow.



Photo 7

Photo looking west at downstream face of Lake Street Bridge.

TABLE 12
SUMMARY OF NATIONAL BRIDGE INVENTORY/STRUCTURE INSPECTION
REPORT FOR LAKE STREET BRIDGE

Summary of Condition Items					
NBI Code #	Condition Items	Score	Score Description	Range of Element Scores	
				Low	High
58	Deck	6	Satisfactory Condition	4	8
59	Superstructure	5	Fair Condition	4	8
60	Substructure	7	Good Condition	5	7
61	Channel and Protection	7	Good Condition	6	7
Summary of Appraisal Items					
NBI Code #	Appraisal Items	Score	Score Description		
67	Structural Evaluation	5	Somewhat better than minimum adequacy to tolerate being left in place as is		
68	Deck Geometry	9	Superior to present desirable criteria		
69	Structural Underclearance	N	Not Applicable		
71	Waterway Adequacy	3	Basically intolerable requiring high priority of corrective action		
72	Approach Alignment	8	Equal to present desirable criteria		
Findings and Recommendations					
Key Comments in Maintenance Report		Monitor cracking and settlement in deck wearing surface. Monitor cracking in deck soffit. Rehabilitate exterior beams and diaphragms. Repair or replace expansion joints. Repair spalls in abutment 1. Monitor cracking in pier walls. Monitor piers for scour.			
Sufficiency Rating		79.2 – FUNCTIONALLY OBSOLETE			
Source: Nevada Department of Transportation; National Bridge Inventory/Structure Inspection Report for B304, 18 April 2002					

TABLE 13
SUMMARY OF LAKE STREET BRIDGE SCOUR ANALYSIS

Data Category	Report Findings
Report Title	Scour Analysis Report – Bridge No. B-304 February 1997
Hydrology ⁽¹⁾	8,300 cfs; overtopping. The structure has seen flows in excess of the of the evaluation discharge 9 times since its construction in 1937.
Scour Analyses ⁽²⁾ Thalweg Elevation Footing Foundation Elevation Local Scour Depth Contract Scour Long Term Bottom Scour Hole Elevation	4472.04ft MSL 4465.9 ft MSL 8.53 ft 0.0 ft 0.0 ft 4463.51 ft MSL
Local Scour	Local scour was applied to the pier experiencing the worst-case scour condition. Since both piers to appear to be equally influenced by river discharge, the calculated pier scour was applied equally to both piers. These evaluations did not reflect the effect of pressure flow. Pressure flow could substantially increase the scour depths for flows greater than the event used in this analysis.
Contraction Scour	Contraction scour is not anticipated.
Long Term Scour	In the vicinity of structure B-304, the Truckee River channel alignment is considered stable. The long term scour assessment was determined to be 0.0 feet.
Abutment Scour	From field observations, both abutments appear to be stable and not currently at risk of instability.
Scour Vulnerability Rating ⁽²⁾	3 – Bridge is scour critical; bridge foundations determined to be unstable for calculated scour; scour below spread footing base or pile tips. A value of 3 was assigned because of the estimated depth of scour was large enough to place the scour hole below the footing and thus make the bridge scour critical. A more severe rating (such as a 2, 1, or 0) was not assigned because the field review did not observe extensive scour nor imminent failure of piers/abutments.
Report Findings	The report assessed that that the Scour Vulnerability Rating of 3 did not represent an appropriate level of risk for the bridge. The report concluded that the structure is not currently at unusual risk of failure from scour.
<p><i>(1) – FHWA mandates the peak flow to be used in scour evaluations is to be the lesser of either the 500-year peak flow or the overtopping flow.</i></p> <p><i>(2)– Scour analyses performed using procedures from FHWA Hydraulic Engineering Circular No. 18, Evaluating Scour at Bridges (FHWA HEC - 18 Third Edition). Scour Vulnerability Rating based on National Bridge Inventory Item 113 code. Hydraulic Input data determined from HEC-RAS Version 1.1.</i></p>	

8. East 2nd Street Bridge

The existing 2nd Street Bridge consists of a concrete deck with steel underdeck and is supported by a single pier. The deck carries two way traffic (one lane each way) and has a parallel parking strip and a pedestrian sidewalk, as shown in **Photo 8**.

Information obtained for the East 2nd Bridge included a Scour Analysis Report, National Bridge Inventory/Structure Inspection Report and various design drawings. The bridge was inspected and evaluated as part of the National Bridge Inventory in 2002. As shown in **Table 14**, the East 2nd Street Bridge received a Sufficiency Rating of 96.9. Following the January 1997 flood, the NDOT conducted a scour analysis of the bridge. The bridge foundations are considered stable with respect to scour, as shown in **Table 15**. Other information obtained regarding the bridge included a set of as-built drawings for the current structure that was completed in 1970.

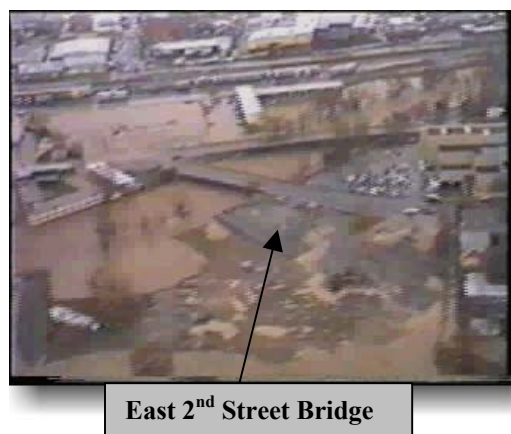


Photo 8

Photo looking north east at East 2nd Street Bridge and Kuenzli Avenue Bridge (downstream bridge).

TABLE 14
SUMMARY OF NATIONAL BRIDGE INVENTORY/STRUCTURE INSPECTION
REPORT FOR EAST 2ND STREET BRIDGE

Summary of Condition Items					
NBI Code #	Condition Items	Score	Score Description	Range of Element Scores	
				Low	High
58	Deck	7	Good Condition	4	7
59	Superstructure	7	Good Condition	7	7
60	Substructure	7	Good Condition	6	8
61	Channel and Protection	7	Good Condition	6	8
Summary of Appraisal Items					
NBI Code #	Appraisal Items	Score	Score Description		
67	Structural Evaluation	7	Better than present minimum criteria		
68	Deck Geometry	7	Better than present minimum criteria		
69	Structural Underclearance	N	Not Applicable		
71	Waterway Adequacy	8	Equal to present desirable criteria		
72	Approach Alignment	8	Equal to present desirable criteria		
Findings and Recommendations					
Key Comments in Maintenance Report		Replace expansion joints. Repair wingwalls. Monitor cracks in abutment back walls and pier. Monitor riprap. Monitor deterioration along horizontal joint at the intermediate pier.			
Sufficiency Rating		96.9			
Source: Nevada Department of Transportation; National Bridge Inventory/Structure Inspection Report for B1326E, 18 April 2002					

TABLE 15
SUMMARY OF EAST 2nd STREET BRIDGE SCOUR ANALYSIS

Data Category	Report Findings
Report Title	Scour Analysis Report – Bridge No. B-1326E February 1997
Hydrology ⁽¹⁾	25,018 cfs, overtopping flow. Since construction in 1970, the structure has not experienced any large flows that approach the evaluation discharge.
Scour Analyses ⁽²⁾ Thalweg Elevation Footing Foundation Elevation Local Scour Depth Contract Scour Long Term Bottom Scour Hole Elevation	4469.68 ft MSL 4464.1 ft MSL (abutment) 0 ft (no piers) 0.0 ft 0.0 ft 4469.68 ft MSL
Local Scour	Since this is a single span bridge, there are no piers and consequently there is no local scour.
Contraction Scour	Contraction scour is not anticipated.
Long Term Scour	In the vicinity of structure B-1326E, the Truckee River channel alignment is considered stable. The long term scour assessment was determined to be 0.0 feet.
Abutment Scour	The bridge abutments may be at risk of erosion based on the following information: <ul style="list-style-type: none"> - From HEC-18, the existing riprap on the left and right bank are undersized by 55%. - Abutments have not experienced hydraulic conditions nearing the evaluation discharge.
Scour Vulnerability Rating ⁽²⁾	5 – Bridge foundations determined to be stable for calculated scour conditions; scour within limits of footings or piles. A value of 5 was assigned because the estimated depth of scour placed the resulting channel invert elevation well above the nearest bridge footing. A more severe rating (such as 4) was not assigned because the field review did not observe exposed foundations resulting from the effects of additional erosion.
Report Findings	The report assessed that the Scour Vulnerability Rating of 5 represented an appropriate level of risk for the bridge. The report concluded that the structure is currently at risk of failure from scour.
<p><i>(1) – FHWA mandates the peak flow to be used in scour evaluations is to be the lesser of either the 500-year peak flow or the overtopping flow.</i></p> <p><i>(2)– Scour analyses performed using procedures from FHWA Hydraulic Engineering Circular No. 18, Evaluating Scour at Bridges (FHWA HEC - 18 Third Edition). Scour Vulnerability Rating based on National Bridge Inventory Item 113 code. Hydraulic Input data determined from HEC-RAS Version 1.1.</i></p>	

9. Kuenzli Avenue Bridge

The existing Kuenzli Street Bridge consists of a concrete deck with steel underdeck and is supported by a single pier, as shown in **Photo 9**. The deck carries two way traffic (one lane each way) and has a parallel parking strip and a pedestrian sidewalk.

Information obtained for the Kuenzli Avenue Bridge included a Scour Analysis Report and a NBI Structure Inspection Report. The bridge was inspected and evaluated as part of the National Bridge Inventory in 2002. As shown in **Table 16**, Kuenzli Avenue Bridge received a Sufficiency Rating of 96.9. Following the January 1997 flood, the NDOT conducted a scour analysis of the

bridge. The bridge is considered “scour critical”, as shown in **Table 17**. No design drawings were obtained for the bridge.

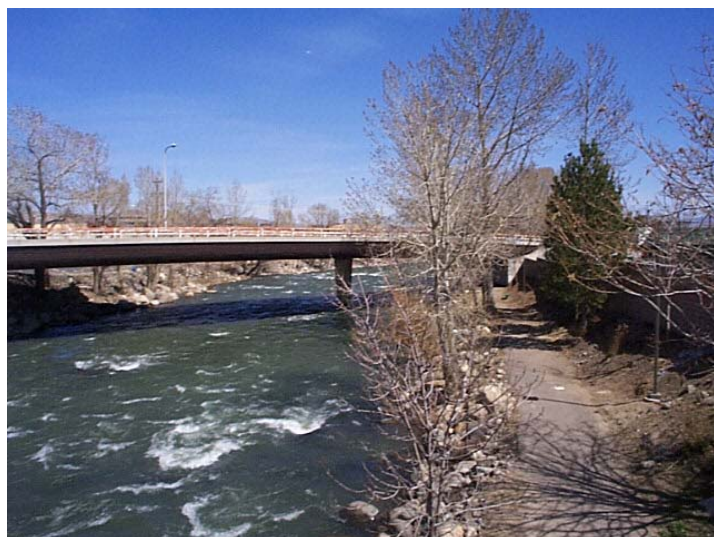


Photo 9

Photo looking east at upstream face of Kuenzli Avenue Bridge.

TABLE 16
SUMMARY OF NATIONAL BRIDGE INVENTORY/STRUCTURE INSPECTION
REPORT FOR KUENZLI STREET BRIDGE

Summary of Condition Items					
NBI Code #	Condition Items	Score	Score Description	Range of Element Scores	
				Low	High
58	Deck	7	Good Condition	4	7
59	Superstructure	7	Good Condition	6	8
60	Substructure	6	Satisfactory Condition	5	8
61	Channel and Protection	7	Good Condition	6	8
Summary of Appraisal Items					
NBI Code #	Appraisal Items	Score	Score Description		
67	Structural Evaluation	7	Better than present minimum criteria		
68	Deck Geometry	7	Better than present minimum criteria		
69	Structural Underclearance	N	Not Applicable		
71	Waterway Adequacy	8	Equal to present desirable criteria		
72	Approach Alignment	8	Equal to present desirable criteria		
Findings and Recommendations					
Key Comments in Maintenance Report		Repair spall in parapet and along top edges of the abutments. Rehabilitate joints. Monitor cracks in wing walls. Monitor west bank for erosion due to insufficient riprap coverage.			
Sufficiency Rating		96.9			
Source: Nevada Department of Transportation; National Bridge Inventory/Structure Inspection Report for B1327E, 18 April 2002					

TABLE 17
SUMMARY OF KUENZLI AVENUE BRIDGE SCOUR ANALYSIS

Data Category	Report Findings
Report Title	Scour Analysis Report – Bridge No. B-1327W February 1997
Hydrology ⁽¹⁾	35,277 cfs; overtopping flow. Since construction in 1968, the structure has not experienced any large flows that approach the evaluation discharge.
Scour Analyses ⁽²⁾ Thalweg Elevation Footing Foundation Elevation Local Scour Depth Contract Scour Long Term Bottom Scour Hole Elevation	4468.28 ft MSL 4458.5 ft MSL (abutment) 21.93 ft (no piers) 0.0 ft 0.0 ft 4445.67 ft MSL
Local Scour	The local scour exceeds the bottom footing elevation by approximately 12.8 feet.
Contraction Scour	Considering the analysis, contraction scour is anticipated to be approximately 0.68 feet. Calculations indicate clear-water scour conditions prevail.
Long Term Scour	In the vicinity of structure B-1327-W, the Truckee River channel alignment is considered stable. The long term scour assessment was determined to be 0.0 feet.
Abutment Scour	The bridge abutments appear to be adequately protected with riprap volume.
Scour Vulnerability Rating ⁽²⁾	3 – Bridge is scour critical; bridge foundations determined to be unstable for calculated scour; scour below spread footing base or pile tips. A value of 3 was assigned because of the estimated depth of scour was large enough to place the scour hole below the footing and thus make the bridge scour critical. A more severe rating (such as a 2, 1, or 0) was not assigned because the field review did not observe extensive scour nor imminent failure of piers/abutments.
Report Findings	The report assessed that that the Scour Vulnerability Rating of 3 represented an appropriate level of risk for the bridge. The report concluded that the structure is not currently at risk of failure from scour.
<i>(1) – FHWA mandates the peak flow to be used in scour evaluations is to be the lesser of either the 500-year peak flow or the overtopping flow.</i> <i>(2)– Scour analyses performed using procedures from FHWA Hydraulic Engineering Circular No. 18, Evaluating Scour at Bridges (FHWA HEC - 18 Third Edition). Scour Vulnerability Rating based on National Bridge Inventory Item 113 code. Hydraulic Input data determined from HEC-RAS Version 1.1.</i>	

C. SUMMARY OF ANALYSES FOR EXISTING BRIDGES

The primary information obtained for the Downtown Reno Reach bridges included Scour Analysis Reports, National Bridge Inventory Data / Structure Inspection Reports and various design drawings. **Table 18** summarizes the key findings from the Scour Analysis Reports and National Bridge Inventory for the nine downtown bridges. The design drawings obtained for these bridges are also summarized.

TABLE 18
SUMMARY OF PREVIOUS ANALYSES AND EVALUATIONS OF EXISTING
DOWNTOWN RENO BRIDGES

Bridge	Bridge Number	Bridge Sufficiency Rating	Scour Vulnerability Rating	As-Built or Other Drawings
Booth Street	B-1621	96.7	NA	Booth Street 1 sheet, September 1991
Keystone Avenue	B-1530	49.3 Structurally Deficient	3 Scour Critical	Keystone Avenue Bridge and Extensions 17 sheets (17 of 17 structural sheets), September 1965
North Arlington	B- 1532	81.3	3 Scour Critical	1 st Set - Widening North Bridge over North Branch of Truckee River at Chestnut Street (Arlington Avenue) 3 sheets (3 of 3), August 1938 2 nd set - Arlington Avenue Bridge Widening 5 sheets (5 of 5), March 1966
South Arlington	B-1531	62.1 Structurally Deficient	5 Stable	Rigid Frame Bridge over North Branch of Truckee River at Chestnut Street (Arlington Avenue) 4 sheets (4 of 4), August 1938
Sierra Street	B-303	54.6 Structurally Deficient	3 Scour Critical	
Virginia Street	B-178	2.0 Structurally Deficient	3 Scour Critical	Design of Reinforced Bridge for Virginia Street 2 sheets, Not Dated
Lake Street	B-304	79.2 Functionally Obsolete	3 Scour Critical	
East Second Street	B-1326E	96.6	5 Stable	East Second Street Bridge Replacement 4 sheets (4 of 13), September 1970
Kuenzli Street	B-1327W	96.6	3 Scour Critical	

CHAPTER III

HYDRAULIC CHARACTERISTICS OF DOWNTOWN RENO ALTERNATIVES AND RELATED BRIDGE CONSIDERATIONS

A. DEVELOPMENT OF DOWNTOWN RENO ALTERNATIVES

Through a collaborative community process during 2000 -2002, five alternatives were developed for the Downtown Reno reach to reduce flood damages:

- Rehabilitation Alternative,
- Rehabilitation – New Span Alternative,
- Matching Bridges Alternative,
- Landmark Bridges Alternative, and
- Widening Alternative.

Two previous reports identified the measures and containment alignments for these five alternatives:

- *Flood Damage Reduction Alternatives Report Addressing Downtown Reno Bridges*, June 2002,
- *Revised Draft Seepage Impact Memorandum, Downtown Reno Reach*, January 2004.

Table 19 summarizes the features currently proposed for each of the five flood damage alternatives. The approach to reducing flood damages in the Downtown Reno Reach varies among the five alternatives. The Rehabilitation Alternative and Rehabilitation Alternative – New Span preserve the Sierra, Virginia, and Lake Street Bridges through rehabilitation. The Matching Bridges Alternative and the Widening Alternative increase bridge flow areas by replacing the Sierra, Virginia, and Lake Street Bridges with structures that are similar in design to the recently constructed Center Street Bridge. The fifth alternative, the Landmark Bridges Alternative, also improves conveyance by replacing the Sierra, Virginia, and Lake Street Bridges with clear span bridges.

All alternatives have floodwalls or levees to provide containment of flows. However, each alternative yields a different design water surface elevation, creating differences in floodwall and levee heights between the alternatives. **Table 19** summarizes other differences between alternatives such as the channel widening measure in the Widening and Rehabilitation – New Span Alternatives. The Rehabilitation – New Span Alternative also includes a plaza concept and an additional span of the Virginia Street Bridge. The plaza concept is a widening of the channel that excavates the entire Mid Block and Mapes Site to generate additional flow area without having to remove the Historic Virginia Street Bridge.

TABLE 19
FLOOD DAMAGE REDUCTION MEASURES INCORPORATED INTO DOWNTOWN
RENO ALTERNATIVES

Type	Flood Damage Reduction Measure		Alternative				
			Rehabilitation	Rehabilitation – New Span	Matching Bridges	Landmark Bridges	Widening
Containment Features	Floodwalls	On-Bank Floodwall	X	X	X	X	X
		In-Channel Floodwall	X	X	X	X	X
		Terraced Floodwall	X	X	X	X	X
	Levees		X	X	X	X	X
	Flood Proofing		X	X	X	X	X
	Temporary Closure Structures (i.e closure at bridges)		X	X	X	X	X
	Erosion Protection		X	X	X	X	X
Channel Improvements/ Widening	Channelization		(1)	(1)	(1)	(1)	(1)
	Channel Widening			X			X
	Plaza Areas			X			
	Mini-Span / New Span	Sierra Street Bridge		X			
		Virginia Street Bridge		X			
		Center Street Bridge		X			X
	Culvert at Lake Street			X			X
Bridge Modifications	Bridge Replacement	Clear Span Design				X	
		Center Street Design			X		X
	Bridge Rehabilitation		X	X			
(1) NOTE: Due to the construction of the Reno Whitewater Park, the channelization measure is no longer included in any of the current Downtown Reno alternatives. However, the HEC-RAS models have not been updated from previous efforts to reflect the removal of the channelization features.							

B. HEC-RAS MODEL

The with-project water surface elevations were simulated with a HEC-RAS steady flow model. A discussion of the modeling process is included in the *Flood Damage Reduction Alternatives Report Addressing Downtown Reno Bridges*, 2002. The with-project water surface elevations presented in **Plate 2** include channelization (i.e. regrading of the river channel) between Keystone Avenue and Sierra Street. Due to the construction of the Downtown Reno Whitewater Park, channelization has been eliminated from each of the five alternatives. However, HEC-RAS simulation of the five alternatives including the new Whitewater Park and excluding the channelization have not been completed at this time.

The design water surface elevations, used for sizing flood control features, were obtained by adding the Risk and Uncertainty factors to the with-project water surface elevations developed through the HEC-RAS simulations. R&U factors used in the design of the flood control features for each of the alternatives in the Downtown Reno area are shown in **Table 20**. The design water surface elevations, including R&U, are shown in **Plate 3**. As noted above, these design water surfaces are based on modeling simulations that included channelization.

TABLE 20
RISK AND UNCERTAINTY (R&U) FACTORS

Alternative	R&U ⁽¹⁾ (feet)
Rehabilitation Alternative	4.3
Rehabilitation – New Span Alternative	4.1
Matching Bridges Alternative	4.7
Landmark Bridges Alternative	5.5
Widening Alternative	6.6
⁽¹⁾ Based on Bruce Shaffer email Downtown Reno Risk Analysis dated 08 May 2003.	

C. HEC-RAS RESULTS

Although previous bridge evaluations and scour studies were conducted for the bridges in the downtown area, it is possible that modifications to the channel, related to the flood damage reduction alternatives, will further impact bridge scour and stability. HEC-RAS modeling results are an initial indicator of where potential impacts to bridge conditions may occur. Further studies may be required to determine the extent of the impacts. In addition, the HEC-RAS simulations can assist in determining areas where the alternatives are not affecting bridge conditions and no further analysis is necessary. The data was taken from the most current HEC-RAS study that modeled each alternative for the *Flood Damage Reduction Alternatives Report Addressing Downtown Reno Bridges*, 2002. Under the previous HEC-RAS study, each alternative had included channelization (i.e. regrading of the river channel) between Keystone Avenue and Sierra Street. During the time period between the previous study and this bridge evaluation, the Downtown Reno Whitewater Park has been constructed. The river channel modifications, related to the Whitewater Park, make the channelization unfeasible. However, incorporation of the Whitewater Park and elimination of the channelization feature within the HEC-RAS model have not been completed at this time. Therefore, all bridge comparisons will utilize design water surface elevations presented in **Plate 3**, and the other associated modeling data, that still incorporate the channelization feature for all alternatives. Ultimately, a similar comparison of with and with-out project conditions should be conducted once the Whitewater Park geometry has been incorporated into the model and channelization features have been removed.

Three main concerns related to flood flows were addressed in this comparison, 1) Bridge Scour, 2) Uplift Pressure, and 3) Overtopping.

Bridge scour is directly related the flow velocities. Typically, as the velocity of the flow increases so do the effects of scour. With this in mind, a velocity comparison of design flows between existing conditions and with-project conditions was conducted. As shown in **Table 21**, all alternatives generally increased velocities through the upper portions of the Downtown Reno reach. No change in velocity was observed for any of the alternatives at bridges in the lower reach, East 2nd Street and Kuenzli Avenue.

Determining whether uplift pressure was a concern for each bridge was completed by verifying if water had entered into a state of pressure flow. Evaluation of pressure flow conditions were completed by taking the design water surface (i.e. the sum of the with-project water surface

elevations and R&U value) and comparing this with the bridge's low chord elevation. If the design water surface was greater than the low chord elevation, then the water has entered into pressure flow. These comparisons are shown in **Table 22** for each of the Downtown Reno bridges for each alternative. It should be noted that many of these bridges have been subjected to pressure flow multiple times during the life of these structures. However, the various flood control alternatives may increase the frequency and duration of pressure flow conditions.

Overtopping is the condition where the water surface elevation exceeds the high chord (top of the bridge deck) of the bridge. Overtopping conditions were identified by comparing the design water surface (i.e. the sum of the with-project water surface elevations and R&U) with the high chord elevation. If the design water surface elevation was greater than the high chord elevation, then water was overtopping the bridge. It should be noted that many of these bridges have been subjected to overtopping multiple times during the life of these structures. However, the various flood control alternatives may increase the frequency and duration of overtopping conditions.

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TABLE 21 – CHANNEL VELOCITY AT BRIDGE CROSS SECTIONS UNDER EXISTING CONDITIONS AND WITH THE FIVE DOWNTOWN RENO FLOOD CONTROL ALTERNATIVES

D
R
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TABLE 22 – DESIGN WATER SURFACE ELEVATIONS AT BRIDGE CROSS SECTIONS
UNDER EXISTING CONDITIONS AND WITH THE FIVE DOWNTOWN RENO FLOOD
CONTROL ALTERNATIVES

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CHAPTER IV FINDINGS AND RECOMMENDATIONS

A. GENERAL DISCUSSION

- The City of Reno owns all of the bridges in the Downtown Reno area. The City of Reno is also responsible for regular maintenance of the bridges. The Nevada Department of Transportation (NDOT) completes inspections and evaluations of the bridges every other year. This information is included in the National Bridges Inventory.
- It is suggested that any additional analyses be coordinated with NDOT. NDOT staff, including Bill Crawford, Bridge Division Chief, and Chris Miller, Hydraulics Section, provided the Scour Analyses Reports and Nation Bridge Inventory/Structure Inspection Reports that are summarized in this report.
- Any additional scour analyses should be completed with an updated HEC-RAS model that includes the Reno Whitewater Park. As the existing modeling simulations included the channelization measure, significant hydraulic differences are observed between the with-project and with-out project (i.e. existing conditions) simulations. However as considerable channel regrading has occurred as a result of the Whitewater Park (a with-out project condition), changes in hydraulic characteristics (i.e. velocity) may be smaller when comparing the new with-out project and with-project simulations.

B. BRIDGE SPECIFIC DISCUSSION

1. Booth Street Bridge

The key considerations of the Booth Street Bridge include:

- The bridge was recently constructed in 1994.
- The bridge received a Sufficiency Rating of 96.7 and all elements were considered in very good or good condition after inspection and evaluation in 2002.
- The bridge foundations were identified as “stable” (8 score in Item 113) in the bridge’s 2002 Bridge Inspection Report.
- Currently, none of the five Downtown Reno alternatives propose any modifications to the bridge.
- All five alternatives, based on the most recent HEC-RAS simulations, increase velocities immediately upstream of the bridge, through the bridge, and immediately downstream of the bridge.

Recommendations relating to the Booth Street Bridge include:

- As the bridge was recently constructed and is in very good condition, additional structural analyses do not appear warranted at this time.

- Considering the significant increases in velocity and the observed erosion after the 1997 flood event, it is recommended to conduct scour analyses in order to identify any scour mitigation measures that may be required. Such analyses should be completed with an updated HEC-RAS model that includes the Whitewater Park features.

2. **Keystone Avenue Bridge**

The key considerations of the Keystone Avenue Bridge include:

- The bridge received a Sufficiency Rating of 49.3 and was identified as “structurally deficient” after inspection and evaluation in 2002.
- The bridge foundations received a “scour critical” designation (NBI Item 113 score of 3) in the bridge’s 1997 Scour Analysis Report.
- Currently, none of the five Downtown Reno alternatives propose any modifications to the bridge.
- All five alternatives, based on the most recent HEC-RAS simulations, increase velocities immediately upstream of the bridge, through the bridge, and immediately downstream of the bridge.
- Design water surface elevations of the five alternatives are significantly below the low chord of the bridge.

Recommendations relating to the Keystone Avenue Bridge include:

- The proposed alternatives would not modify the frequency of pressure flow through the bridge or overtopping of the bridge. The flood control project would generate very minor changes in loadings to the piers and substructure elements during 100-year or smaller events. Additional structural analyses do not appear warranted at this time.
- Considering the increases in velocity and the bridge’s previous designation as “scour critical”, it is recommended to conduct additional scour analyses in order to identify any scour mitigation measures that may be required. Such analyses should be completed with an updated HEC-RAS model that includes the Whitewater Park features.

3. **Arlington Avenue – North Bridge**

The key considerations of the Arlington Avenue – North Bridge include:

- The bridge received a Sufficiency Rating of 81.3 after inspection and evaluation in 2002, however the maintenance report noted “widespread deterioration warrants structural analysis and probable rehabilitation/replacement of deck, superstructure and substructure”.
- The bridge foundations received a “scour critical” designation (NBI Item 113 score of 3) in the bridge’s 1997 Scour Analysis Report.
- Currently, none of the five Downtown Reno alternatives propose any modifications to the bridge.

- Four of the five alternatives, based on the most recent HEC-RAS simulations, increase velocities immediately upstream of the bridge, through the bridge, and immediately downstream of the bridge.
- The frequency of the bridge being subjected to pressure flow conditions would increase for all alternatives. The frequency of the bridge being overtopped by flood flows would also increase for all alternatives.

Recommendations relating to the Arlington Avenue – North Bridge include:

- Based on existing concerns regarding the structural adequacy of the bridge (i.e. maintenance report noting “widespread deterioration warrant structural analysis and probable rehabilitation/replacement of deck, superstructure and substructure”), additional structural analyses appear to be warranted.
- Considering the increases in velocity and the observed erosion after the 1997 flood event, it is recommended to conduct scour analyses in order to identify any scour mitigation measures that may be required. Such analyses should be completed with an updated HEC-RAS model that includes the Whitewater Park features.

4. **Arlington Avenue – South Bridge**

The key considerations of the Arlington Avenue – South Bridge include:

- The bridge received a Sufficiency Rating of 62.1 and was identified as “structurally deficient” after inspection and evaluation in 2002.
- The bridge foundations received a “stable” designation (NBI Item 113 score of 5) in the bridge’s 1997 Scour Analysis Report.
- Currently, none of the five Downtown Reno alternatives propose any modifications to the bridge.
- Four of the five alternatives, based on the most recent HEC-RAS simulations, increase velocities immediately upstream of the bridge, through the bridge, and immediately downstream of the bridge.
- The frequency of the bridge being subjected to pressure flow conditions would increase for all alternatives. The frequency of the bridge being overtopped by flood flows would also increase for all alternatives.

Recommendations relating to the Arlington Avenue – South Bridge include:

- Based on existing concerns regarding the structural adequacy of the bridge (i.e. identified as “structurally deficient”), additional structural analyses appear to be warranted.
- Considering the significant increases in velocity for most alternatives, it is recommended to conduct scour analyses in order to identify any scour mitigation measures that may be required for the abutments. Such analyses should be completed with an updated HEC-RAS model that includes the Whitewater Park features.

5. Sierra Street Bridge

The key considerations of the Sierra Street Bridge include:

- The bridge was constructed in 1937.
- The bridge received a Sufficiency Rating of 54.6 and was identified as “structurally deficient” after inspection and evaluation in 2002.
- The bridge foundations received a “scour critical” designation (NBI Item 113 score of 3) in the bridge’s 1997 Scour Analysis Report.
- Currently, all of the five Downtown Reno alternatives propose either rehabilitation or replacement of the structure.
- All five alternatives, based on the most recent HEC-RAS simulations, increase velocities immediately upstream of the bridge, through the bridge, and immediately downstream of the bridge.
- The frequency of the bridge being subjected to pressure flow conditions would increase for the two alternatives proposing rehabilitation. The frequency of the bridge being overtopped by flood flows would also increase for the two alternatives proposing rehabilitation.

Recommendations relating to the Sierra Street Bridge include:

- Based on existing concerns regarding the structural adequacy of the bridge (i.e. identified as “structurally deficient”), additional structural analyses appear to be warranted for the two alternatives that propose rehabilitation of the bridge. Such analyses would be used to determine if the bridge rehabilitation would be required as part of the flood control project.
- Considering the significant increases in velocity and the observed erosion after the 1997 flood event, it is recommended to conduct scour analyses in order to identify any scour mitigation measures that may be required for the two alternatives that rehabilitate the bridge. Such analyses should be completed with an updated HEC-RAS model that includes the Whitewater Park features.

6. Virginia Street Bridge

The key considerations of the Virginia Street Bridge include:

- The bridge was constructed in 1905 and is listed on the National Register of Historic Places.
- The bridge received a Sufficiency Rating of 2.0 and was identified as “structurally deficient” after inspection and evaluation in 2002.
- The bridge received a “scour critical” designation (NBI Item 113 score of 3) in the bridge’s 1997 Scour Analysis Report.
- Currently, all of the five Downtown Reno alternatives propose either rehabilitation or replacement of the structure.

- All five alternatives, based on the most recent HEC-RAS simulations, increase velocities immediately upstream of the bridge, through the bridge, and immediately downstream of the bridge.
- The frequency of the bridge being subjected to pressure flow conditions would increase for the two alternatives proposing rehabilitation. The frequency of the bridge being overtopped by flood flows would also increase for the two alternatives proposing rehabilitation.

Recommendations relating to the Virginia Street Bridge include:

- Based on existing concerns regarding the structural adequacy of the bridge (i.e. identified as “structurally deficient”), additional structural analyses appear to be warranted for the two alternatives that propose rehabilitation of the bridge. Such analyses would be used to determine if the bridge rehabilitation would be required as part of the flood control project.
- Considering the increases in velocity, it is recommended to conduct scour analyses in order to identify any scour mitigation measures that may be required for the two alternatives that propose rehabilitation of the bridge. Such analyses should be completed with an updated HEC-RAS model that includes the Whitewater Park features.

7. **Lake Street Bridge**

The key considerations of the Lake Street Bridge include:

- The bridge received a Sufficiency Rating of 79.2 and was identified as “Functionally Obsolete” after inspection and evaluation in 2002.
- The bridge received a “scour critical” designation (NBI Item 113 score of 3) in the bridge’s 1997 Scour Analysis Report.
- Currently, all of the five Downtown Reno alternatives propose either rehabilitation or replacement of the structure.
- All five alternatives, based on the most recent HEC-RAS simulations, increase velocities immediately upstream of the bridge, through the bridge, and immediately downstream of the bridge.
- The frequency of the bridge being subjected to pressure flow conditions would increase for the two alternatives proposing rehabilitation. The frequency of the bridge being overtopped by flood flows would also increase for the two alternatives proposing rehabilitation.

Recommendations relating to the Lake Street Bridge include:

- Additional structural analyses are recommended in order to determine if bridge rehabilitation would be required as part of the flood control project.
- Considering the increases in velocity, it is recommended to conduct scour analyses in order to identify any scour mitigation measures that may be required. Such analyses should be completed with an updated HEC-RAS model that includes the Whitewater Park features.

8. East 2nd Street Bridge

The key considerations of the East 2nd Street Bridge include:

- The bridge received a Sufficiency Rating of 96.6 after inspection and evaluation in 2002.
- The bridge foundations received a “stable” designation (NBI Item 113 score of 5) in the bridge’s 1997 Scour Analysis Report.
- Currently, none of the five Downtown Reno alternatives propose any modifications to the bridge.
- None of the five alternatives, based on the most recent HEC-RAS simulations, increase velocities within the vicinity of the bridge or through the bridge.
- Design water surface elevations of the five alternatives are below the low chord of the bridge.

Recommendations relating to the East 2nd Street Bridge include:

- The proposed alternatives would not modify the frequency of pressure flow or overtopping through the bridge. No additional structural analyses are recommended.
- None of the five alternatives alter the hydraulics within the vicinity of the bridge (i.e. velocities and water surface elevations are the same under with-project and existing conditions). No additional scour analyses are recommended.

9. Kuenzli Avenue Bridge

The key considerations of the Kuenzli Avenue Bridge include:

- The bridge received a Sufficiency Rating of 96.6 after inspection and evaluation in 2002.
- The bridge received a “scour critical” designation (NBI Item 113 score of 3) in the bridge’s 1997 Scour Analysis Report.
- Currently, none of the five Downtown Reno alternatives propose any modifications to the bridge.
- None of the five alternatives, based on the most recent HEC-RAS simulations, increase velocities within the vicinity of the bridge or through the bridge.
- Design water surface elevations of the five alternatives are below the low chord of the bridge.

Recommendations relating to the Kuenzli Avenue Bridge include:

- The proposed alternatives would not modify the frequency of pressure flow or overtopping through the bridge. No additional structural analyses are recommended.
- None of the five alternatives alter the hydraulics within the vicinity of the bridge (i.e. velocities and water surface elevations are the same under with-project and existing conditions). No additional scour analyses are recommended.

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- Nevada Department of Transportation. 1997. Scour Analysis Report, Bridge No. B-178 Spanning Truckee River.
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- Nevada Department of Transportation. 1997. Scour Analysis Report, Bridge No. B-1326-E Spanning Truckee River.
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Existing Conditions

Description	River Station	Water Surface Elevation (ft)	Velocity (ft/sec)	Bridge High Chord (ft)	Bridge Low Chord (ft)
Booth Street	52.930	4516.31	5.41	4513.8	4510
	52.925 U	4516.31	10.44		
	52.925 D	4515.77	11.13		
	52.920	4512.79	9.26		
Keystone Avenue	52.820	4510.1	10.65	4522	4517
	52.815 U	4509.89	9.98		
	52.815 D	4508.65	11.88		
	52.810	4508.79	12.52		
N Arlington Avenue	52.317	4502.67	4.6	4503.3	4496.2
	52.309 U	4502.76	6.4		
	52.309 D	4502.06	6.3		
	52.301	4501.92	5.07		
S Arlington Avenue	52.317	4502.67	4.6	4500.9	4495.2
	52.309 U	4502.41	7.8		
	52.309 D	4502.13	7.81		
	52.301	4501.92	5.07		
Sierra Street	52.159	4500.79	7.49	4499.5	4492.9
	52.1535 U	4500.79	10.44		
	52.1535 D	4500.79	10.66		
	52.148	4498.53	8.9		
Virginia Street	52.093	4498.31	7.66	4499.2	4494.6
	52.0855 U	4498.31	12.04		
	52.0855 D	4498.31	12.43		
	52.078	4495.44	9.29		
Center Street	52.000	4495.14	8.28	4498.2	4492.2
	51.995 U	4494.13	11.21		
	51.995 D	4493.68	11.25		
	51.990	4494.2	8.9		
Lake Street	51.920	4494.08	7.69	4494.14	4485.94
	51.915 U	4494.08	12.58		
	51.915 D	4494.08	12.92		
	51.910	4490.27	10.38		
East 2nd Street	51.730	4485.19	14.48	4500.88	4491.78
	51.725 U	4485	14.76		
	51.725 D	4484.95	13.98		
	51.720	4483.84	15.96		
Kuenzli Street	51.690	4484.19	9.76	4497.5	4493.5
	51.685 U	4483.99	10.17		
	51.685 D	4483.73	10.46		
	51.680	4483.83	10.13		

Rehabilitation Alternative

Description	River Station	Water Surface Elevation (ft)	R & U (ft)	Water Surface Elevation w/ R & U (ft)	Velocity (ft/sec)	Bridge High Chord (ft)	Bridge Low Chord (ft)
Booth Street	52.930	4514.72	4.3	4519.02	10.15	4513.8	4510
	52.925 U	4514.72	4.3	4519.02	15.82		
	52.925 D	4514.72	4.3	4519.02	13.04		
	52.920	4511.63	4.3	4515.93	12.46		
Keystone Avenue	52.820	4509.83	4.3	4514.13	12.08	4522	4517
	52.815 U	4509.49	4.3	4513.79	12.44		
	52.815 D	4508.7	4.3	4513	12.79		
	52.810	4508.84	4.3	4513.14	12.72		
N Arlington Avenue	52.317	4503.24	4.3	4507.54	4.13	4503.3	4496.2
	52.309 U	4503.35	4.3	4507.65	4.3		
	52.309 D	4502.76	4.3	4507.06	5.69		
	52.301	4502.61	4.3	4506.91	4.82		
S Arlington Avenue	52.317	4503.24	4.3	4507.54	4.13	4500.9	4495.2
	52.309 U	4502.94	4.3	4507.24	6.58		
	52.309 D	4502.68	4.3	4506.98	7.47		
	52.301	4502.61	4.3	4506.91	4.82		
Sierra Street	52.159	4501.62	4.3	4505.92	7.64	4499.5	4492.9
	52.1535 U	4501.62	4.3	4505.92	11.26		
	52.1535 D	4501.5	4.3	4505.8	11.32		
	52.148	4499.03	4.3	4503.33	8.74		
Virginia Street	52.093	4498.96	4.3	4503.26	7.42	4499.2	4494.6
	52.0855 U	4498.96	4.3	4503.26	12.56		
	52.0855 D	4498.96	4.3	4503.26	12.94		
	52.078	4495.89	4.3	4500.19	9.03		
Center Street	52.000	4495.67	4.3	4499.97	7.93	4498.2	4492.2
	51.995 U	4494.62	4.3	4498.92	10.92		
	51.995 D	4494.09	4.3	4498.39	11.26		
	51.990	4494.65	4.3	4498.95	8.64		
Lake Street	51.920	4494.48	4.3	4498.78	7.7	4494.14	4485.94
	51.915 U	4494.48	4.3	4498.78	13.37		
	51.915 D	4494.48	4.3	4498.78	15.24		
	51.910	4490.27	4.3	4494.57	10.38		
East 2nd Street	51.730	4485.19	4.3	4489.49	14.48	4500.88	4491.78
	51.725 U	4485	4.3	4489.3	14.76		
	51.725 D	4484.95	4.3	4489.25	13.98		
	51.720	4483.84	4.3	4488.14	15.96		
Kuenzli Street	51.690	4484.19	4.3	4488.49	9.76	4497.5	4493.5
	51.685 U	4483.99	4.3	4488.29	10.17		
	51.685 D	4483.73	4.3	4488.03	10.46		
	51.680	4483.83	4.3	4488.13	10.13		

Rehabilitation New Span Alternative

Description	River Station	Water Surface Elevation (ft)	R & U (ft)	Water Surface Elevation w/ R & U (ft)	Velocity (ft/sec)	Bridge High Chord (ft)	Bridge Low Chord (ft)
Booth Street	52.930	4514.76	4.1	4518.86	10.12	4513.8	4510
	52.925 U	4514.76	4.1	4518.86	15.79		
	52.925 D	4514.76	4.1	4518.86	12.98		
	52.920	4511.69	4.1	4515.79	12.41		
Keystone Avenue	52.820	4509.92	4.1	4514.02	11.87	4522	4517
	52.815 U	4509.58	4.1	4513.68	12.31		
	52.815 D	4508.73	4.1	4512.83	12.74		
	52.810	4508.87	4.1	4512.97	12.68		
N Arlington Avenue	52.317	4501.79	4.1	4505.89	4.9	4503.3	4496.2
	52.309 U	4501.88	4.1	4505.98	6.59		
	52.309 D	4500.91	4.1	4505.01	8.73		
	52.301	4500.26	4.1	4504.36	6.83		
S Arlington Avenue	52.317	4501.79	4.1	4505.89	4.9	4500.9	4495.2
	52.309 U	4501.51	4.1	4505.61	8.55		
	52.309 D	4501.49	4.1	4505.59	9.71		
	52.301	4500.26	4.1	4504.36	6.83		
Sierra Street	52.159	4499.4	4.1	4503.5	7.72	4499.5	4492.9
	52.1535 U	4499.4	4.1	4503.5	12.46		
	52.1535 D	4499.4	4.1	4503.5	12.72		
	52.148	4496.67	4.1	4500.77	6.95		
Virginia Street	52.093	4496.92	4.1	4501.02	4.15	4499.2	4494.6
	52.0855 U	4494.6	4.1	4498.7	9.25		
	52.0855 D	4494.6	4.1	4498.7	9.81		
	52.078	4494.95	4.1	4499.05	5.66		
Center Street	52.000	4494.08	4.1	4498.18	8.35	4498.2	4492.2
	51.995 U	4493.39	4.1	4497.49	10.5		
	51.995 D	4492.96	4.1	4497.06	10.59		
	51.990	4493.33	4.1	4497.43	8.86		
Lake Street	51.920	4493.22	4.1	4497.32	7.1	4494.14	4485.94
	51.915 U	4493.22	4.1	4497.32	12.69		
	51.915 D	4493.22	4.1	4497.32	13.21		
	51.910	4489.85	4.1	4493.95	8.86		
East 2nd Street	51.730	4485.19	4.1	4489.29	14.48	4500.88	4491.78
	51.725 U	4485	4.1	4489.1	14.76		
	51.725 D	4484.95	4.1	4489.05	13.98		
	51.720	4483.84	4.1	4487.94	15.96		
Kuenzli Street	51.690	4484.19	4.1	4488.29	9.76	4497.5	4493.5
	51.685 U	4483.99	4.1	4488.09	10.17		
	51.685 D	4483.73	4.1	4487.83	10.46		
	51.680	4483.83	4.1	4487.93	10.13		

Matching Bridges Alternative

Description	River Station	Water Surface Elevation (ft)	R & U (ft)	Water Surface Elevation w/ R & U (ft)	Velocity (ft/sec)	Bridge High Chord (ft)	Bridge Low Chord (ft)
Booth Street	52.930	4514.72	4.7	4519.42	10.15	4513.8	4510
	52.925 U	4514.72	4.7	4519.42	15.82		
	52.925 D	4514.72	4.7	4519.42	13.04		
	52.920	4511.63	4.7	4516.33	12.46		
Keystone Avenue	52.820	4509.84	4.7	4514.54	12.07	4522	4517
	52.815 U	4509.5	4.7	4514.2	12.42		
	52.815 D	4508.71	4.7	4513.41	12.76		
	52.810	4508.86	4.7	4513.56	12.7		
N Arlington Avenue	52.317	4501.88	4.7	4506.58	4.85	4503.3	4496.2
	52.309 U	4501.98	4.7	4506.68	6.37		
	52.309 D	4500.96	4.7	4505.66	8.44		
	52.301	4500.43	4.7	4505.13	6.73		
S Arlington Avenue	52.317	4501.88	4.7	4506.58	4.85	4500.9	4495.2
	52.309 U	4501.59	4.7	4506.29	8.64		
	52.309 D	4501.59	4.7	4506.29	9.8		
	52.301	4500.43	4.7	4505.13	6.73		
Sierra Street	52.159	4499.16	4.7	4503.86	8.66	4500.5	4495.2
	52.1535 U	4499.16	4.7	4503.86	11.7		
	52.1535 D	4499.16	4.7	4503.86	11.73		
	52.148	4497.05	4.7	4501.75	9.8		
Virginia Street	52.093	4496.84	4.7	4501.54	8.53	4500.3	4495
	52.0855 U	4496.84	4.7	4501.54	10.35		
	52.0855 D	4496.84	4.7	4501.54	10.38		
	52.078	4494.37	4.7	4499.07	9.96		
Center Street	52.000	4493.93	4.7	4498.63	9.05	4498.2	4492.2
	51.995 U	4493.17	4.7	4497.87	11.26		
	51.995 D	4492.72	4.7	4497.42	11.26		
	51.990	4493.1	4.7	4497.8	9.57		
Lake Street	51.920	4492.76	4.7	4497.46	8.79	4494.2	4488.7
	51.915 U	4492.76	4.7	4497.46	12.37		
	51.915 D	4492.76	4.7	4497.46	12.56		
	51.910	4490.27	4.7	4494.97	10.38		
East 2nd Street	51.730	4485.19	4.7	4489.89	14.48	4500.88	4491.78
	51.725 U	4485	4.7	4489.7	14.76		
	51.725 D	4484.95	4.7	4489.65	13.98		
	51.720	4483.84	4.7	4488.54	15.96		
Kuenzli Street	51.690	4484.19	4.7	4488.89	9.76	4497.5	4493.5
	51.685 U	4483.99	4.7	4488.69	10.17		
	51.685 D	4483.73	4.7	4488.43	10.46		
	51.680	4483.83	4.7	4488.53	10.13		

Landmark Bridges Alternative

Description	River Station	Water Surface Elevation (ft)	R & U (ft)	Water Surface Elevation w/ R & U (ft)	Velocity (ft/sec)	Bridge High Chord (ft)	Bridge Low Chord (ft)
Booth Street	52.930	4514.72	5.5	4520.22	10.14	4513.8	4510
	52.925 U	4514.72	5.5	4520.22	15.82		
	52.925 D	4514.72	5.5	4520.22	13.03		
	52.920	4511.64	5.5	4517.14	12.46		
Keystone Avenue	52.820	4509.84	5.5	4515.34	12.07	4522	4517
	52.815 U	4509.5	5.5	4515	12.43		
	52.815 D	4508.71	5.5	4514.21	12.77		
	52.810	4508.86	5.5	4514.36	12.7		
N Arlington Avenue	52.317	4498.83	5.5	4504.33	7.17	4503.3	4496.2
	52.309 U	4498.63	5.5	4504.13	10.74		
	52.309 D	4498.63	5.5	4504.13	14.22		
	52.301	4496.65	5.5	4502.15	11.91		
S Arlington Avenue	52.317	4498.83	5.5	4504.33	7.17	4500.9	4495.2
	52.309 U	4499.18	5.5	4504.68	7.43		
	52.309 D	4499.1	5.5	4504.6	8.44		
	52.301	4496.65	5.5	4502.15	11.91		
Sierra Street	52.159	4493.83	5.5	4499.33	12.08	*	*
	52.1535 U	*	5.5	*	*		
	52.1535 D		5.5				
	52.148	4493.51	5.5	4499.01	12.42		
Virginia Street	52.093	4492.88	5.5	4498.38	11.06	*	*
	52.0855 U	*	5.5	*	*		
	52.0855 D		5.5				
	52.078	4492.59	5.5	4498.09	11.31		
Center Street	52.000	4491.8	5.5	4497.3	10.52	4498.2	4492.2
	51.995 U	4491.25	5.5	4496.75	11.95		
	51.995 D	4490.73	5.5	4496.23	12.45		
	51.990	4491.07	5.5	4496.57	11.13		
Lake Street	51.920	4490.34	5.5	4495.84	10.6	*	*
	51.915 U	*	5.5	*	*		
	51.915 D		5.5				
	51.910	4490.27	5.5	4495.77	10.38		
East 2nd Street	51.730	4485.19	5.5	4490.69	14.48	4500.88	4491.78
	51.725 U	4485	5.5	4490.5	14.76		
	51.725 D	4484.95	5.5	4490.45	13.98		
	51.720	4483.84	5.5	4489.34	15.96		
Kuenzli Street	51.690	4484.19	5.5	4489.69	9.76	4497.5	4493.5
	51.685 U	4483.99	5.5	4489.49	10.17		
	51.685 D	4483.73	5.5	4489.23	10.46		
	51.680	4483.83	5.5	4489.33	10.13		

* The Sierra, Virginia, and Lake Street Bridges were removed in the HEC-RAS Model to simulate the Landmark Bridges Alternative concept. Therefore, there is no data associated with those cross-sections.

Widening Alternative

Description	River Station	Water Surface Elevation (ft)	R & U (ft)	Water Surface Elevation w/ R & U (ft)	Velocity (ft/sec)	Bridge High Chord (ft)	Bridge Low Chord (ft)
Booth Street	52.930	4514.76	6.6	4521.36	10.12	4513.8	4510
	52.925 U	4514.76	6.6	4521.36	15.79		
	52.925 D	4514.76	6.6	4521.36	12.99		
	52.920	4511.69	6.6	4518.29	12.41		
Keystone Avenue	52.820	4509.92	6.6	4516.52	11.87	4522	4517
	52.815 U	4509.58	6.6	4516.18	12.31		
	52.815 D	4508.73	6.6	4515.33	12.74		
	52.810	4508.87	6.6	4515.47	12.68		
N Arlington Avenue	52.317	4500.39	6.6	4506.99	5.94	4503.3	4496.2
	52.309 U	4500.57	6.6	4507.17	7.06		
	52.309 D	4499.92	6.6	4506.52	9.35		
	52.301	4498.37	6.6	4504.97	9.3		
S Arlington Avenue	52.317	4500.39	6.6	4506.99	5.94	4500.9	4495.2
	52.309 U	4499.68	6.6	4506.28	13.6		
	52.309 D	4499.42	6.6	4506.02	15.43		
	52.301	4498.37	6.6	4504.97	9.3		
Sierra Street	52.159	4497.35	6.6	4503.95	5.94	4500.5	4495.2
	52.1535 U	4497.35	6.6	4503.95	10.83		
	52.1535 D	4497.35	6.6	4503.95	10.92		
	52.148	4493.85	6.6	4500.45	9.3		
Virginia Street	52.093	4493.48	6.6	4500.08	9.75	4500.3	4495
	52.0855 U	4492.93	6.6	4499.53	10.88		
	52.0855 D	4492.56	6.6	4499.16	11.24		
	52.078	4492.88	6.6	4499.48	10.23		
Center Street	52.000	4492.49	6.6	4499.09	9.31	4498.2	4492.2
	51.995 U	4492.06	6.6	4498.66	10.58		
	51.995 D	4491.67	6.6	4498.27	10.9		
	51.990	4491.91	6.6	4498.51	9.81		
Lake Street	51.920	4491.64	6.6	4498.24	8.2	4494.2	4488.7
	51.915 U	4488.7	6.6	4495.3	11.19		
	51.915 D	4488.7	6.6	4495.3	10.71		
	51.910	4489.77	6.6	4496.37	9.15		
East 2nd Street	51.730	4485.19	6.6	4491.79	14.48	4500.88	4491.78
	51.725 U	4485	6.6	4491.6	14.76		
	51.725 D	4484.95	6.6	4491.55	13.98		
	51.720	4483.84	6.6	4490.44	15.96		
Kuenzli Street	51.690	4484.19	6.6	4490.79	9.76	4497.5	4493.5
	51.685 U	4483.99	6.6	4490.59	10.17		
	51.685 D	4483.73	6.6	4490.33	10.46		
	51.680	4483.83	6.6	4490.43	10.13		

TABLE 21
CHANNEL VELOCITY AT BRIDGE CROSS SECTIONS UNDER EXISTING CONDINTIONS AND WITH THE FIVE DOWNTOWN RENO FLOOD CONTROL ALTERNATIVES

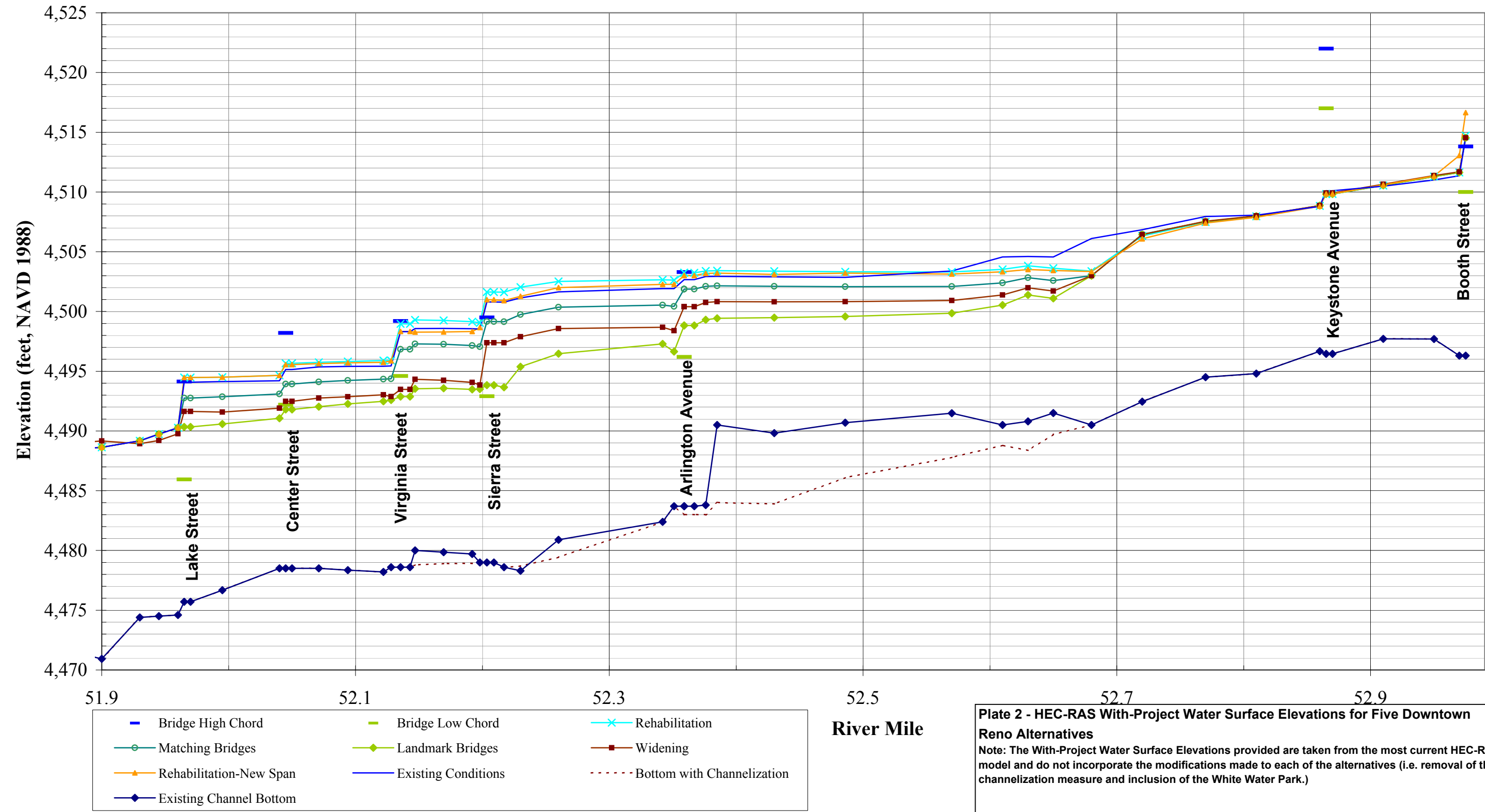
Description	River Station	Existing Conditions Velocity (ft/s)	Rehabilitation Alternative				Rehabilitation New Span Alternative				Matching Bridges Alternative				Landmark Bridges Alternative				Widening Alternative			
			Velocity (ft/s)	Change in Velocity (ft/s)	% Change in Velocity (%)	Pressure Flow? (Y or N)	Velocity (ft/s)	Change in Velocity (ft/s)	% Change in Velocity (%)	Pressure Flow? (Y or N)	Velocity (ft/s)	Change in Velocity (ft/s)	% Change in Velocity (%)	Pressure Flow? (Y or N)	Velocity (ft/s)	Change in Velocity (ft/s)	% Change in Velocity (%)	Pressure Flow? (Y or N)	Velocity (ft/s)	Change in Velocity (ft/s)	% Change in Velocity (%)	Pressure Flow? (Y or N)
Booth Street	52.930	5.41	10.15	4.74	87.62%		10.12	4.71	87.06%		10.15	4.74	87.62%		10.14	4.73	87.43%		10.12	4.71	87.06%	
	52.925 U	10.44	15.82	5.38	51.53%	Y	15.79	5.35	51.25%	Y	15.82	5.38	51.53%	Y	15.82	5.38	51.53%	Y	15.79	5.35	51.25%	Y
	52.925 D	11.13	13.04	1.91	17.16%	Y	12.98	1.85	16.62%	Y	13.04	1.91	17.16%	Y	13.03	1.9	17.07%	Y	12.99	1.86	16.71%	Y
	52.920	9.26	12.46	3.2	34.56%		12.41	3.15	34.02%		12.46	3.2	34.56%		12.46	3.2	34.56%		12.41	3.15	34.02%	
Keystone Avenue	52.820	10.65	12.08	1.43	13.43%		11.87	1.22	11.46%		12.07	1.42	13.33%		12.07	1.42	13.33%		11.87	1.22	11.46%	
	52.815 U	9.98	12.44	2.46	24.65%	N	12.31	2.33	23.35%	N	12.42	2.44	24.45%	N	12.43	2.45	24.55%	N	12.31	2.33	23.35%	N
	52.815 D	11.88	12.79	0.91	7.66%	N	12.74	0.86	7.24%	N	12.76	0.88	7.41%	N	12.77	0.89	7.49%	N	12.74	0.86	7.24%	N
	52.810	12.52	12.72	0.2	1.60%		12.68	0.16	1.28%		12.7	0.18	1.44%		12.7	0.18	1.44%		12.68	0.16	1.28%	
N Arlington Avenue	52.317	4.6	4.13	-0.47	-10.22%		4.9	0.3	6.52%		4.85	0.25	5.43%		7.17	2.57	55.87%		5.94	1.34	29.13%	
	52.309 U	6.4	4.3	-2.1	-32.81%	Y	6.59	0.19	2.97%	Y	6.37	-0.03	-0.47%	Y	10.74	4.34	67.81%	Y	7.06	0.66	10.31%	Y
	52.309 D	6.3	5.69	-0.61	-9.68%	Y	8.73	2.43	38.57%	Y	8.44	2.14	33.97%	Y	14.22	7.92	125.71%	Y	9.35	3.05	48.41%	Y
	52.301	5.07	4.82	-0.25	-4.93%		6.83	1.76	34.71%		6.73	1.66	32.74%		11.91	6.84	134.91%		9.3	4.23	83.43%	
S Arlington Avenue	52.317	4.6	4.13	-0.47	-10.22%		4.9	0.3	6.52%		4.85	0.25	5.43%		7.17	2.57	55.87%		5.94	1.34	29.13%	
	52.309 U	7.8	6.58	-1.22	-15.64%	Y	8.55	0.75	9.62%	Y	8.64	0.84	10.77%	Y	7.43	-0.37	-4.74%	Y	13.6	5.8	74.36%	Y
	52.309 D	7.81	7.47	-0.34	-4.35%	Y	9.71	1.9	24.33%	Y	9.8	1.99	25.48%	Y	8.44	0.63	8.07%	Y	15.43	7.62	97.57%	Y
	52.301	5.07	4.82	-0.25	-4.93%		6.83	1.76	34.71%		6.73	1.66	32.74%		11.91	6.84	134.91%		9.3	4.23	83.43%	
Sierra Street	52.159	7.49	7.64	0.15	2.00%		7.72	0.23	3.07%		8.66	1.17	15.62%		12.08	4.59	61.28%		5.94	-1.55	-20.69%	
	52.1535 U	10.44	11.26	0.82	7.85%	Y	12.46	2.02	19.35%	Y	11.7	1.26	12.07%	Y	*	*	*	*	10.83	0.39	3.74%	Y
	52.1535 D	10.66	11.32	0.66	6.19%	Y	12.72	2.06	19.32%	Y	11.73	1.07	10.04%	Y	*	*	*	*	10.92	0.26	2.44%	Y
	52.148	8.9	8.74	-0.16	-1.80%		6.95	-1.95	-21.91%		9.8	0.9	10.11%		12.42	3.52	39.55%		9.3	0.4	4.49%	
Virginia Street	52.093	7.66	7.42	-0.24	-3.13%		4.15	-3.51	-45.82%		8.53	0.87	11.36%		11.06	3.4	44.39%		9.75	2.09	27.28%	
	52.0855 U	12.04	12.56	0.52	4.32%	Y	9.25	-2.79	-23.17%	Y	10.35	-1.69	-14.04%	Y	*	*	*	*	10.88	-1.16	-9.63%	Y
	52.0855 D	12.43	12.94	0.51	4.10%	Y	9.81	-2.62	-21.08%	Y	10.38	-2.05	-16.49%	Y	*	*	*	*	11.24	-1.19	-9.57%	Y
	52.078	9.29	9.03	-0.26	-2.80%		5.66	-3.63	-39.07%		9.96	0.67	7.21%		11.31	2.02	21.74%		10.23	0.94	10.12%	
Center Street	52.000	8.28	7.93	-0.35	-4.23%		8.35	0.07	0.85%		9.05	0.77	9.30%		10.52	2.24	27.05%		9.31	1.03	12.44%	
	51.995 U	11.21	10.92	-0.29	-2.59%	Y	10.5	-0.71	-6.33%	Y	11.26	0.05	0.45%	Y	11.95	0.74	6.60%	Y	10.58	-0.63	-5.62%	Y
	51.995 D	11.25	11.26	0.01	0.09%	Y	10.59	-0.66	-5.87%	Y	11.26	0.01	0.09%	Y	12.45	1.2	10.67%	Y	10.9	-0.35	-3.11%	Y
	51.990	8.9	8.64	-0.26	-2.92%		8.86	-0.04	-0.45%		9.57	0.67	7.53%		11.13	2.23	25.06%		9.81	0.91	10.22%	
Lake Street	51.920	7.69	7.7	0.01	0.13%		7.1	-0.59	-7.67%		8.79	1.1	14.30%		10.6	2.91	37.84%		8.2	0.51	6.63%	
	51.915 U	12.58	13.37	0.79	6.28%	Y	12.69	0.11	0.87%	Y	12.37	-0.21	-1.67%	Y	*	*	*	*	11.19	-1.39	-11.05%	Y
	51.915 D	12.92	15.24	2.32	17.96%	Y	13.21	0.29	2.24%	Y	12.56	-0.36	-2.79%	Y	*	*	*	*	10.71	-2.21	-17.11%	Y
	51.910	10.38	10.38	0	0.00%		8.86	-1.52	-14.64%		10.38	0	0.00%		10.38	0	0.00%		9.15	-1.23	-11.85%	
East 2nd Street	51.730	14.48	14.48	0	0.00%		14.48	0	0.00%		14.48	0	0.00%		14.48	0	0.00%		14.48	0	0.00%	
	51.725 U	14.76	14.76	0	0.00%	N	14.76	0	0.00%	N	14.76	0	0.00%	N	14.76	0	0.00%	N	14.76	0	0.00%	N
	51.725 D	13.98	13.98	0	0.00%	N	13.98	0	0.00%	N	13.98	0	0.00%	N	13.98	0	0.00%	N	13.98	0	0.00%	N
	51.720	15.96	15.96	0	0.00%		15.96	0	0.00%		15.96	0	0.00%		15.96	0	0.00%		15.96	0	0.00%	
Kuenzli Street	51.690	9.76	9.76	0	0.00%		9.76	0	0.00%		9.76	0	0.00%		9.76	0	0.00%		9.76	0	0.00%	
	51.685 U	10.17	10.17	0	0.00%	N	10.17	0	0.00%	N	10.17	0	0.00%	N	10.17	0	0.00%	N	10.17	0	0.00%	N
	51.685 D	10.46	10.46	0	0.00%	N	10.46	0	0.00%	N	10.46	0	0.00%	N	10.46	0	0.00%	N	10.46	0	0.00%	N
	51.680	10.13	10.13	0	0.00%		10.13	0	0.00%		10.13	0	0.00%		10.13	0	0.00%		10.13	0	0.00%	

* The Sierra, Virginia, and Lake Street Bridges were removed in the HEC-RAS Model to simulate the Landmark Bridges Alternative concept. Therefore, there is no data associated with those cross-sections.

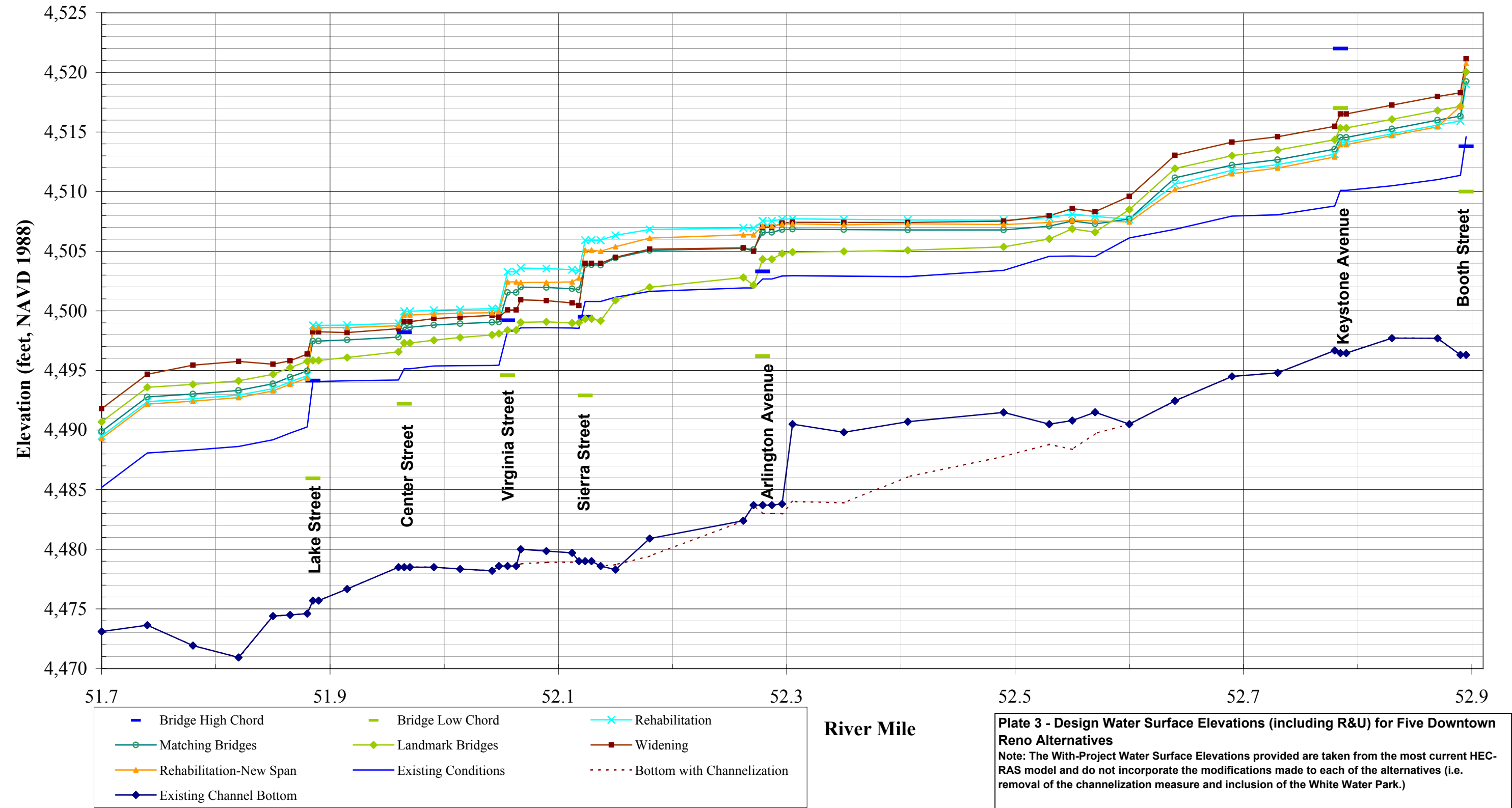
TABLE 22
DESIGN WATER SURFACE ELEVATIONS AT BRIDGE CROSS SECTIONS UNDER EXISTING CONDINTIONS AND WITH THE FIVE DOWNTOWN RENO FLOOD CONTROL ALTERNATIVES

Description	Existing Conditions			Rehabilitation Alternative						Rehabilitation New Span Alternative					Matching Bridges Alternative					Landmark Bridges Alternative					Widening Alternative									
	River Station	Water Surface Elevation (ft)	Bridge High Chord (ft)	Bridge Low Chord (ft)	Water Surface Elevation w/ R & U (ft)	Bridge High Chord (ft)	Bridge Low Chord (ft)	Pressure Flow? (Y or N)	Overtopping? (Y or N)	Water Surface Elevation w/ R & U (ft)	Bridge High Chord (ft)	Bridge Low Chord (ft)	Pressure Flow? (Y or N)	Overtopping? (Y or N)	Water Surface Elevation w/ R & U (ft)	Bridge High Chord (ft)	Bridge Low Chord (ft)	Pressure Flow? (Y or N)	Overtopping? (Y or N)	Water Surface Elevation w/ R & U (ft)	Bridge High Chord (ft)	Bridge Low Chord (ft)	Pressure Flow? (Y or N)	Overtopping? (Y or N)	Water Surface Elevation w/ R & U (ft)	Bridge High Chord (ft)	Bridge Low Chord (ft)	Pressure Flow? (Y or N)	Overtopping? (Y or N)					
Booth Street	52.930	4516.31			4519.02					4518.86					4519.42					4520.22					4521.36									
	52.925 U	4516.31	4513.8	4510	4519.02	4513.8	4510	Y	Y	4518.86	4513.8	4510	Y	Y	4519.42	4513.8	4510	Y	Y	4520.22	4513.8	4510	Y	Y	4521.36	4513.8	4510	Y	Y	4521.36	4513.8	4510	Y	Y
	52.925 D	4515.77			4519.02			Y	Y	4518.86			Y	Y	4519.42			Y	Y	4520.22			Y	Y	4521.36			Y	Y					
	52.920	4512.79			4515.93					4515.79					4516.33					4517.14					4518.29									
Keystone Avenue	52.820	4510.1			4514.13					4514.02					4514.54					4515.34					4516.52									
	52.815 U	4509.89	4522	4517	4513.79	4522	4517	N	N	4513.68	4522	4517	N	N	4514.2	4522	4517	N	N	4515	4522	4517	N	N	4516.18	4522	4517	N	N	4516.18	4522	4517	N	N
	52.815 D	4508.65			4513			N	N	4512.83			N	N	4513.41			N	N	4514.21			N	N	4515.33			N	N					
	52.810	4508.79			4513.14					4512.97					4513.56					4514.36					4515.47									
N Arlington Avenue	52.317	4502.67			4507.54					4505.89					4506.58					4504.33					4506.99									
	52.309 U	4502.76	4503.3	4496.2	4507.65	4503.3	4496.2	Y	Y	4505.98	4503.3	4496.2	Y	Y	4506.68	4503.3	4496.2	Y	Y	4504.13	4503.3	4496.2	Y	Y	4507.17	4503.3	4496.2	Y	Y	4507.17	4503.3	4496.2	Y	Y
	52.309 D	4502.06			4507.06			Y	Y	4505.01			Y	Y	4505.66			Y	Y	4504.13			Y	Y	4506.52			Y	Y					
	52.301	4501.92			4506.91					4504.36					4505.13					4502.15					4504.97									
S Arlington Avenue	52.317	4502.67			4507.54					4505.89					4506.58					4504.33					4506.99									
	52.309 U	4502.41	4500.9	4495.2	4507.24	4500.9	4495.2	Y	Y	4505.61	4500.9	4495.2	Y	Y	4506.29	4500.9	4495.2	Y	Y	4504.68	4500.9	4495.2	Y	Y	4506.28	4500.9	4495.2	Y	Y	4506.28	4500.9	4495.2	Y	Y
	52.309 D	4502.13			4506.98			Y	Y	4505.59			Y	Y	4506.29			Y	Y	4504.6			Y	Y	4506.02			Y	Y					
	52.301	4501.92			4506.91					4504.36					4505.13					4502.15					4504.97									
Sierra Street	52.159	4500.79			4505.92					4503.5					4503.86					4499.33					4503.95									
	52.1535 U	4500.79	4499.5	4492.9	4505.92	4499.5	4492.9	Y	Y	4503.5	4499.5	4492.9	Y	Y	4503.86	4500.5	4495.2	Y	Y	*	*	*	*	*	4503.95	4500.5	4495.2	Y	Y	4503.95	4500.5	4495.2	Y	Y
	52.1535 D	4500.79			4505.8			Y	Y	4503.5			Y	Y	4503.86			Y	Y	*			*	*	4503.95			Y	Y					
	52.148	4498.53			4503.33					4500.77					4501.75					4499.01					4500.45									
Virginia Street	52.093	4498.31			4503.26					4501.02					4501.54					4498.38					4500.08									
	52.0855 U	4498.31	4499.2	4494.6	4503.26	4499.2	4494.6	Y	Y	4498.7	4499.2	4494.6	Y	N	4501.54	4500.3	4495	Y	Y	*	*	*	*	*	4499.53	4500.3	4495	Y	N	4499.53	4500.3	4495	Y	N
	52.0855 D	4498.31			4503.26			Y	Y	4498.7			Y	N	4501.54			Y	Y	*			*	*	4499.16			Y	N					
	52.078	4495.44			4500.19					4499.05					4499.07					4498.09					4499.48									
Center Street	52.000	4495.14			4499.97					4498.18					4498.63					4497.3					4499.09									
	51.995 U	4494.13	4498.2	4492.2	4498.92	4498.2	4492.2	Y	Y	4497.49	4498.2	4492.2	Y	N	4497.87	4498.2	4492.2	Y	N	4496.75	4498.2	4492.2	Y	N	4498.66	4498.2	4492.2	Y	Y	4498.66	4498.2	4492.2	Y	Y
	51.995 D	4493.68			4498.39			Y	Y	4497.06			Y	N	4497.42			Y	N	4496.23			Y	N	4498.27			Y	Y					
	51.990	4494.2			4498.95					4497.43					4497.8					4496.57					4498.51									
Lake Street	51.920	4494.08			4498.78					4497.32					4497.46					4495.84					4498.24									
	51.915 U	4494.08	4494.14	4485.94	4498.78	4494.14	4485.94	Y	Y	4497.32	4494.1	4485.9	Y	Y	4497.46	4494.2	4488.7	Y	Y	*	*	*	*	*	4495.3	4494.2	4488.7	Y	Y	4495.3	4494.2	4488.7	Y	Y
	51.915 D	4494.08			4498.78			Y	Y	4497.32			Y	Y	*			*	*	4495.3			Y	Y										
	51.910	4490.27			4494.57					4493.95					4494.97					4495.77					4496.37									
East 2nd Street	51.730	4485.19			4489.49					4489.29					4489.89					4490.69					4491.79									
	51.725 U	4485	4500.88	4491.78	4489.3	4500.88	4491.78	N	N	4489.1	4500.9	4491.8	N	N	4489.7	4500.9	4491.8	N	N	4490.5	4500.9	4491.8	N	N	4491.6	4500.9	4491.8	N	N	4491.6	4500.9	4491.8	N	N
	51.725 D	4484.95			4489.25			N	N	4489.05			N	N	4489.65			N	N	4490.45			N	N	4491.55			N	N					
	51.720	4483.84			4488.14					4487.94					4488.54					4489.34					4490.44									
Kuenzli Street	51.690	4484.19			4488.49					4488.29					4488.89					4489.69					4490.79									
	51.685 U	4483.99	4497.5	4493.5	4488.29	4497.5	4493.5	N	N	4488.09	4497.5	4493.5	N	N	4488.69	4497.5	4493.5	N	N	4489.49	4497.5	4493.5	N	N	4490.59	4497.5	4493.5	N	N	4490.59	4497.5	4493.5	N	N
	51.685 D	4483.73			4488.03			N	N	4487.83			N	N	4488.43			N	N	4489.23			N	N	4490.33			N	N					
	51.680	4483.83			4488.13					4487.93					4488.53					4489.33					4490.43									

Alternative Profiles @ 20,700 cfs



Alternative Profiles @ 20,700 cfs



Truckee River

Comparison of High Water Marks and HEC-RAS Results

(All Values 1988 Datum)

Description	River	COE	USGS	USGS	City of Reno Flood Boundary Survey						
	Station (miles)	Highwater Survey	1929 Datum	Highwater Survey	Left Bank	Right Bank	Highest	Average			
Booth Street	53.420	4508.4			4510.0	4513.0	4513.0	4511.5			
	53.100										
	52.940										
	52.930										
	52.925										
52.920	4511.0				4509.0	4511.0	4510.0				
52.900											
52.860											
52.820											
52.815											
Keystone	52.810				4504.4	4505.5	4506.0	4506.0	4505.8		
	52.760										
	52.720										
	52.670										
	52.630										
52.600	4504.0	4503.8				4504.0	4503.9				
52.580											
52.560											
52.520											
52.436											
N Arlington	52.380	4503.5				4504.2	4504.2	4503.9			
	52.335										
	52.326										
	52.317										
	52.309										
S Arlington	52.309				4506.0	4509.9	4509.9	4508.0			
	52.301										
	52.292										
	52.210										
	52.180										
Sierra	52.167					4501.0	4503.0	4503.0	4502.0		
	52.159										
	52.154										
	52.148										
	52.142										
Virginia	52.120	4501.0					4501.9	4501.9	4501.5		
	52.097										
	52.093										
	52.086										
	52.078										
	52.072				4492.7		4498.2	4498.2	4495.5		
	52.044										
	52.021										
			4499.0	4498.0						4499.0	4498.5
	4494.0					4496.0	4496.0	4495.0			

Description	River	COE	USGS	USGS	City of Reno Flood Boundary Survey			
	Station (miles)	Highwater Survey	1929 Datum	Highwater Survey	Left Bank	Right Bank	Highest	Average
Center	52.000	4492.0			4499.0	4498.0	4499.0	4498.5
	51.995							
	51.990							
	51.945							
Lake	51.920	4492.0			4495.8	4494.0	4495.8	4494.9
	51.915							
	51.910							
	51.895							
East 2nd	51.880	4492.0			4486.0	4496.0	4496.0	4491.0
	51.850							
	51.810							
	51.770							
Keunzli	51.730	4492.0			4486.0	4496.0	4496.0	4491.0
	51.725							
	51.720							
	51.710							
Wells	51.690	4492.0			4492.0	4483.0	4492.0	4487.5
	51.685							
	51.680							
	51.670							
Kirman	51.640	4492.0			4478.0	4484.0	4484.0	4481.0
	51.610							
	51.570							
	51.550							
	51.540	4492.0			4482.0	4478.0	4482.0	4480.0
	51.510							
	51.470							
	51.460							
	51.440	4492.0			4481.0	4484.0	4484.0	4482.5
	51.420							
	51.410							
	51.380							
	51.340	4492.0			4475.0	4472.0	4475.0	4473.5
	51.310							
	51.270							
	51.230							
	51.180	4492.0			4470.0	4470.0	4470.0	4470.0
	51.170							
	51.150							
	51.145							
	51.139	4492.0			4471.0	4470.0	4471.0	4470.5
	51.130							
	51.080							
	51.070							
	51.040	4492.0			4459.0	4458.0	4459.0	4458.5
	51.000							
	50.960							

	River	COE	USGS	USGS	City of Reno Flood Boundary Survey			
		Highwater Survey	1929 Datum	Highwater Survey	Left Bank	Right Bank	Highest	Average
Kietzke HWY 395	50.920	4455.0	4446.9	4450.4	4457.0	4455.0	4457.0	4456.0
	50.910							
	50.880							
	50.840							
	50.830							
	50.810							
	50.770							
	50.720							
	50.690							
	50.660							
	50.650	4457.0			4454.0	4457.0	4455.5	
	50.640							
	50.630							
	50.565							
	50.537							
	50.48							
	50.381							
	50.253							
	50.124							
	50.048							
	50.01	4446.7						
49.9985								
49.987								
49.959								
49.891								
49.794								
49.713								
49.635								
49.529								
49.497								
49.436	4424.8							
49.43225								
49.4285								
49.44								
49.355								
49.258								
49.165								
49.131								
49.05								
48.957					4423.6			
48.887								
48.838								
48.8305								
48.823								
48.747								
48.698								

	River	COE	USGS	USGS	City of Reno Flood Boundary Survey			
		Highwater Survey	1929 Datum	Highwater Survey	Left Bank	Right Bank	Highest	Average
McCarran EOM	48.584	4403.3	4399.47	4402.97				
	48.47							
	48.364							
	48.209							
	48.105							
	47.986							
	47.79							
	47.671							
	47.622							
	47.6135							
	47.605							
	47.477							
	47.414							
Sparks City Limit Steamboat WTP	47.2	4398.1	4391.76	4395.26				
	47.0	4391.0						
	46.8							
	46.6							
	46.4							
	46.2							
	46.0							
	45.8							
	45.6	4395.8						
	45.4	4395.9						
	45.2							
	45.0							
	44.8							
	44.6							
	44.4							
	44.2							
	44.0							

Truckee River
Comparison of High
 (All Values 1988 Datum)

Description	River Station (miles)	Pyramid Engineers	Mark Forest	Mark Forest	Nimbus Engineers	Channelization Thalweg	Bridge High Chord
		1929 Datum	Highwater Survey 23,000 cfs	Highwater Survey 15,000 cfs	24,500 cfs HEC-RAS		
Booth Street	53.420					4514.8	
	53.100					4500.8	
	52.940					4496.66	
	52.930				4516.8	4496.3	
	52.925					4496.3	4513.8
	52.920				4515.3	4496.3	
Keystone	52.900				4514.8	4497.7	
	52.860				4514.5	4497.71	
	52.820				4514.3	4496.46	
	52.815					4496.46	4522
	52.810		4508.3		4510.7	4496.68	
	52.760				4509.8	4494.8	
	52.720				4509.4	4494.5	
	52.670				4508.0	4492.45	
	52.630				4507.7	4490.5	
	52.600				4505.8	4489.71	
N Arlington S Arlington	52.580					4488.38	
	52.560				4505.7	4488.8	
	52.520				4505.1	4487.79	
	52.436				4503.1	4486.09	
	52.380					4483.9	
	52.335				4503.0	4484.01	
	52.326		4503.9		4503.0	4483	
	52.317				4502.8	4483	
	52.309					4483	4503.3
	52.309					4483	
Sierra	52.301			4495.6	4501.9	4483.7	
	52.292				4501.8	4482.38	
	52.210				4501.2	4479.43	
	52.180		4501.1	4493.3		4478.7	
	52.167				4500.1	4478.59	
	52.159			4493.2	4500.1	4479	
	52.154					4479	4499.5
	52.148				4499.6	4479	
Virginia	52.142			4492.6	4499.6	4478.91	
	52.120				4499.5	4478.9	
	52.097		4498.5	4492.2	4499.5	4478.79	
	52.093				4499.2	4478.6	
	52.086					4478.6	4499.2
	52.078				4496.9	4478.6	
	52.072		4498.4	4491.7	4496.9	4478.2	
	52.044				4496.8	4478.35	
	52.021				4496.7	4478.5	

	River	Pyramid Engineers	Mark Forest	Mark Forest	Nimbus Engineers		
Description	Station (miles)	1929 Datum	Highwater Survey 23,000 cfs	Highwater Survey 15,000 cfs	24,500 cfs HEC-RAS	Channelization Thalweg	Bridge High Chord
Center	52.000				4496.6	4478.5	
	51.995					4478.5	4498.2
	51.990				4494.4	4478.5	
	51.945				4494.2	4476.67	
Lake	51.920		4495.0	4491.3	4494.0	4475.7	
	51.915					4475.7	4494.14
	51.910				4492.4	4474.6	
	51.895				4492.2	4474.5	
East 2nd	51.880				4491.6	4474.4	
	51.850				4490.5	4470.93	
	51.810				4490.0	4471.93	
	51.770					4473.64	
	51.730				4486.2	4473.1	
	51.725					4473.1	4500.88
	51.720				4485.7	4473.2	
	51.710				4485.9	4470.95	
Keunzli	51.690					4472.4	
	51.685					4472.4	4497.5
	51.680					4472.4	
	51.670				4485.9	4469.86	
	51.640				4483.0	4468.5	
	51.610				4482.9	4464.93	
	51.570				4482.6	4465.8	
	51.550					4466.6	
	51.540				4482.7	4463.3	
	51.510				4481.8	4466.8	
	51.470				4481.6	4466.1	
	51.460				4481.7	4465.4	
Wells	51.440					4465.4	4480.06
	51.420				4479.3	4465.4	
	51.410				4479.3	4464.1	
	51.380				4477.6	4462.4	
	51.340				4476.6	4461.1	
	51.310				4474.7	4456.9	
	51.270				4474.5	4456.89	
	51.230				4471.0	4457.73	
	51.180				4469.7	4457	
	51.170					4452.6	
	51.150				4470.7	4452.25	
	51.145					4452.25	4481
Kirman	51.139					4452.25	
	51.130				4470.6	4450.48	
	51.080					4448.4	
	51.070				4465.7	4451.16	
	51.040				4463.1	4448.75	
	51.000				4462.6	4448.98	
	50.960				4461.8	4447.23	

Description	River	Pyramid Engineers	Mark Forest	Mark Forest	Nimbus Engineers		
	Station (miles)	1929 Datum	Highwater Survey 23,000 cfs	Highwater Survey 15,000 cfs	24,500 cfs HEC-RAS	Channelization Thalweg	Bridge High Chord
Kietzke HWY 395	50.920				4461.8	4444.9	
	50.910				4460.7	4444.9	
	50.880				4458.8	4444.8	
	50.840				4459.6	4444.44	
	50.830					4445.4	
	50.810				4459.5	4443.93	
	50.770				4459.5	4441.71	
	50.720				4458.2	4436.4	
	50.690				4458.0	4438.96	
	50.660				4457.4	4436.2	
	50.650				4457.7	4436.63	
	50.640					4436.63	4459.6
	50.630					4436.63	
	50.565					4435.7	
	50.537						
	50.48						
	50.381						
	50.253						
	50.124						
	50.048						
	50.01						
Glendale Ave	49.9985						
	49.987						
	49.959						
	49.891						
	49.794						
	49.713						
	49.635						
	49.529						
	49.497						
	49.436						
Greg Street	49.43225						
	49.4285						
	49.44						
	49.355						
	49.258						
	49.165						
	49.131						
	49.05						
	48.957						
	48.887						
Rock Blvd	48.838						
	48.8305						
	48.823	4413.54	4417.04	4420.54			
	48.747						
	48.698						

	River	Pyramid Engineers	Mark Forest	Mark Forest	Nimbus Engineers		
Description	Station (miles)	1929 Datum	Highwater Survey 23,000 cfs	Highwater Survey 15,000 cfs	24,500 cfs HEC-RAS	Channelization Thalweg	Bridge High Chord
McCarran EOM	48.584	4405.22	4408.72	4412.22			
	48.47	4405.32	4408.82	4412.32			
	48.364						
	48.209	4401.69	4405.19	4408.69			
	48.105						
	47.986	4397.98	4401.48	4404.98			
	47.79						
	47.671						
	47.622						
	47.6135	4399.31	4402.81	4406.31			
	47.605						
Sparks City Limit Steamboat WTP	47.477	4393.02	4396.52	4400.02			
	47.414						
	47.2						
	47.0						
	46.8						
	46.6	4392.83	4396.33	4399.83			
	46.4	4393.17	4396.67	4400.17			
	46.2	4393.43	4396.93	4400.43			
	46.0						
	45.8						
	45.6	4393.02	4396.52	4400.02			
	45.4						
	45.2						
	45.0						
	44.8	4393.08	4396.58	4400.08			
	44.6						
	44.4						
	44.2						
	44.0						

Truckee River
Comparison of High
 (All Values 1988 Datum)

Description	River Station (miles)	Bridge Low Chord	Thalweg	Matching Bridges Alternative C (Replace Sierra, Lake and Virginia St. Bridges)	Matching Bridges Alternative C w/ 4.7' of R&U (Replace Sierra, Lake and Virginia St. Bridges)	Widening Alternative D (Minimum Floodwall Height)
Booth Street	53.420	4510	4514.8	4524.13	4528.83	4524.13
	53.100		4500.8	4516.48	4521.18	4516.5
	52.940		4496.66	4515.09	4519.79	4515.11
	52.930		4496.3	4514.53	4519.23	4514.55
	52.925		4496.3	4514.53	4519.23	4514.55
	52.920		4496.3	4511.63	4516.33	4511.69
	52.900		4497.7	4511.29	4515.99	4511.37
	52.860		4497.71	4510.56	4515.26	4510.65
Keystone	52.820	4517	4496.46	4509.84	4514.54	4509.92
	52.815		4496.46	4509.84	4514.54	4509.92
	52.810		4496.68	4508.86	4513.56	4508.87
	52.760		4494.8	4507.98	4512.68	4508
	52.720		4494.5	4507.52	4512.22	4507.55
	52.670		4492.45	4506.46	4511.16	4506.44
	52.630	4496.2	4490.5	4503	4507.7	4503
	52.600		4491.5	4502.59	4507.29	4501.71
	52.580		4490.8	4502.83	4507.53	4501.98
	52.560		4490.5	4502.4	4507.1	4501.38
	52.520		4491.48	4502.09	4506.79	4500.92
	52.436		4490.7	4502.08	4506.78	4500.82
	52.380		4489.82	4502.11	4506.81	4500.81
	52.335		4490.5	4502.15	4506.85	4500.83
	52.326		4483.8	4502.11	4506.81	4500.76
	52.317		4483.7	4501.88	4506.58	4500.4
	52.309		4483.7	4501.88	4506.58	4500.4
N Arlington S Arlington	52.309		4483.7	4501.88	4506.58	4500.4
	52.301		4483.7	4500.43	4505.13	4498.4
	52.292		4482.4	4500.54	4505.24	4498.68
	52.210		4480.9	4500.36	4505.06	4498.57
	52.180		4478.3	4499.74	4504.44	4497.89
	52.167		4478.6	4499.14	4503.84	4497.39
	52.159		4479	4499.16	4503.86	4497.38
	52.154		4479	4499.16	4503.86	4497.38
	52.148		4479	4497.05	4501.75	4493.85
	52.142		4479.7	4497.15	4501.85	4494.07
Sierra	52.120	4492.9	4479.85	4497.26	4501.96	4494.25
	52.097		4480	4497.29	4501.99	4494.32
	52.093		4478.6	4496.84	4501.54	4493.48
	52.086		4478.6	4496.84	4501.54	4493.48
Virginia	52.078	4494.6	4478.6	4494.37	4499.07	4492.88
	52.072		4478.2	4494.34	4499.04	4493.03
	52.044		4478.35	4494.23	4498.93	4492.87
	52.021		4478.5	4494.11	4498.81	4492.75

Description	River	Bridge Low Chord	Thalweg	Matching Bridges Alternative C (Replace Sierra, Lake and Virginia St. Bridges)	Matching Bridges Alternative C w/ 4.7' of R&U (Replace Sierra, Lake and Virginia St. Bridges)	Widening Alternative D (Minimum Floodwall Height)
	Station (miles)					
Center	52.000		4478.5	4493.93	4498.63	4492.49
	51.995	4492.2	4478.5	4493.93	4498.63	4492.49
	51.990		4478.5	4493.1	4497.8	4491.91
	51.945		4476.67	4492.86	4497.56	4491.58
Lake	51.920		4475.7	4492.76	4497.46	4491.64
	51.915	4485.94	4475.7	4492.76	4497.46	4491.64
	51.910		4474.6	4490.27	4494.97	4489.77
	51.895		4474.5	4489.74	4494.44	4489.21
	51.880		4474.4	4489.18	4493.88	4488.93
	51.850		4470.93	4488.63	4493.33	4489.16
	51.810		4471.93	4488.33	4493.03	4488.84
	51.770		4473.64	4488.08	4492.78	4488.08
	51.730		4473.1	4485.19	4489.89	4485.19
	51.725	4491.78	4473.1	4485.19	4489.89	4485.19
East 2nd	51.720		4473.2	4483.84	4488.54	4483.84
	51.710		4470.95	4483.17	4487.87	4483.17
	51.690		4472.4	4484.19	4488.89	4484.19
	51.685	4493.5	4472.4	4484.19	4488.89	4484.19
	51.680		4472.4	4483.83	4488.53	4483.83
	51.670		4469.86	4483.32	4488.02	4483.32
	51.640		4468.5	4480.87	4485.57	4480.87
	51.610		4464.93	4481.05	4485.75	4481.05
	51.570		4465.8	4480.7	4485.4	4480.7
	51.550		4466.6	4480.79	4485.49	4480.79
Keunzli	51.540		4463.3	4480.83	4485.53	4480.83
	51.510		4466.8	4479.91	4484.61	4479.91
	51.470		4466.1	4479.72	4484.42	4479.72
	51.460		4465.4	4480.03	4484.73	4480.03
	51.440	4474.5	4465.4	4480.03	4484.73	4480.03
	51.420		4465.4	4476.76	4481.46	4476.76
	51.410		4464.1	4476.9	4481.6	4476.9
	51.380		4462.4	4475.2	4479.9	4475.2
	51.340		4461.1	4474.3	4479	4474.3
	51.310		4456.9	4473.07	4477.77	4473.07
Wells	51.270		4456.89	4472.92	4477.62	4472.92
	51.230		4457.73	4469.6	4474.3	4469.6
	51.180		4457	4468.7	4473.4	4468.7
	51.170		4452.6	4469.15	4473.85	4469.15
	51.150		4452.25	4469.14	4473.84	4469.14
	51.145	4474	4452.25	4469.14	4473.84	4469.14
	51.139		4452.25	4468.95	4473.65	4468.95
	51.130		4450.48	4468.87	4473.57	4468.87
	51.080		4448.4	4467.14	4471.84	4467.14
	51.070		4451.16	4463.92	4468.62	4463.92
Kirman	51.040		4448.75	4461.9	4466.6	4461.9
	51.000		4448.98	4460.77	4465.47	4460.77
	50.960		4447.23	4460.13	4464.83	4460.13

Description	River	Bridge Low Chord	Thalweg	Matching Bridges Alternative C (Replace Sierra, Lake and Virginia St. Bridges)	Matching Bridges Alternative C w/ 4.7' of R&U (Replace Sierra, Lake and Virginia St. Bridges)	Widening Alternative D (Minimum Floodwall Height)
	Station (miles)					
Kietzke HWY 395	50.920	4455.5	4444.9	4460.13	4464.83	4460.13
	50.910		4444.9	4459.03	4463.73	4459.03
	50.880		4444.8	4456.33	4461.03	4456.33
	50.840		4444.44	4456.47	4461.17	4456.47
	50.830		4445.4	4456.22	4460.92	4456.22
	50.810		4443.93	4456.21	4460.91	4456.21
	50.770		4441.71	4456.3	4461	4456.3
	50.720		4436.4	4454.22	4458.92	4454.22
	50.690		4438.96	4453.99	4458.69	4453.99
	50.660		4436.2	4452.61	4457.31	4452.61
	50.650		4436.63	4452.84	4457.54	4452.84
	50.640		4436.63	4452.84	4457.54	4452.84
	50.630		4436.63	4451.23	4455.93	4451.23
Glendale Ave	50.565	4455.5	4435.7	4450.03	4454.73	4450.02
	50.537					
	50.48					
	50.381					
	50.253					
	50.124					
	50.048					
	50.01					
	49.9985					
	49.987					
	49.959					
	49.891					
	49.794					
Greg Street	49.713					
	49.635					
	49.529					
	49.497					
	49.436					
	49.43225					
	49.4285					
	49.44					
	49.355					
	49.258					
	49.165					
	49.131					
	49.05					
Rock Blvd	48.957					
	48.887					
	48.838					
	48.8305					
	48.823					
	48.747					
	48.698					

Description	River	Bridge Low Chord	Thalweg	Matching Bridges Alternative C (Replace Sierra, Lake and Virginia St. Bridges)	Matching Bridges Alternative C w/ 4.7' of R&U (Replace Sierra, Lake and Virginia St. Bridges)	Widening Alternative D (Minimum Floodwall Height)
	Station (miles)					
McCarran EOM	48.584					
	48.47					
	48.364					
	48.209					
	48.105					
	47.986					
	47.79					
	47.671					
	47.622					
	47.6135					
	47.605					
	47.477					
	47.414					
Sparks City Limit Steamboat WTP	47.2					
	47.0					
	46.8					
	46.6					
	46.4					
	46.2					
	46.0					
	45.8					
	45.6					
	45.4					
	45.2					
	45.0					
	44.8					
	44.6					
	44.4					
	44.2					
	44.0					

Truckee River
Comparison of High
(All Values 1988 Datum)

Description	River Station (miles)					
		Widening Alternative D w/ 6.6' of R&U (Minimum Floodwall Height)	No Action Alternative (Existing Conditions)	Landmark Bridges Alternative C2 (Removal of Sierra, Lake and Virginia St. Bridges)	Landmark Bridges Alternative C2 w/ 5.5' of R&U (Removal of Sierra, Lake and Virginia St. Bridges)	Rehab -New Span Alternative A4 (Plazas to 1st St./no Br. Replacement)
Booth Street	53.420	4530.73	4524.13	4524.13	4529.63	4524.13
	53.100	4523.1	4516.53	4516.52	4522.02	4517.21
	52.940	4521.71	4515.17	4515.51	4521.01	4516.52
	52.930	4521.15	4514.6	4514.54	4520.04	4516.65
	52.925	4521.15	4514.6	4514.54	4520.04	4516.65
	52.920	4518.29	4511.36	4511.64	4517.14	4513.05
	52.900	4517.97	4511.01	4511.3	4516.8	4511.34
	52.860	4517.25	4510.49	4510.56	4516.06	4510.6
Keystone	52.820	4516.52	4510.1	4509.84	4515.34	4509.85
	52.815	4516.52	4510.1	4509.84	4515.34	4509.85
	52.810	4515.47	4508.79	4508.86	4514.36	4508.81
	52.760	4514.6	4508.06	4507.98	4513.48	4507.88
	52.720	4514.15	4507.95	4507.52	4513.02	4507.4
	52.670	4513.04	4506.84	4506.44	4511.94	4506.08
	52.630	4509.6	4506.11	4503	4508.5	4503.35
	52.600	4508.31	4504.56	4501.1	4506.6	4503.43
N Arlington S Arlington	52.580	4508.58	4504.6	4501.38	4506.88	4503.51
	52.560	4507.98	4504.57	4500.54	4506.04	4503.32
	52.520	4507.52	4503.39	4499.86	4505.36	4503.13
	52.436	4507.42	4502.86	4499.58	4505.08	4503.21
	52.380	4507.41	4502.9	4499.48	4504.98	4503.11
	52.335	4507.43	4502.94	4499.43	4504.93	4503.21
	52.326	4507.36	4502.92	4499.31	4504.81	4503.18
	52.317	4507	4502.67	4498.83	4504.33	4503.01
Sierra	52.309	4507	4502.67	4498.83	4504.33	4503.01
	52.309	4507	4502.67	4498.83	4504.33	4503.01
	52.301	4505	4501.92	4496.65	4502.15	4502.27
	52.292	4505.28	4501.92	4497.29	4502.79	4502.27
	52.210	4505.17	4501.64	4496.47	4501.97	4502
	52.180	4504.49	4501.14	4495.38	4500.88	4501.28
	52.167	4503.99	4500.78	4493.66	4499.16	4500.9
	52.159	4503.98	4500.79	4493.83	4499.33	4500.99
Virginia	52.154	4503.98	4500.79	4493.83	4499.33	4500.99
	52.148	4500.45	4498.53	4493.51	4499.01	4498.65
	52.142	4500.67	4498.56	4493.48	4498.98	4498.33
	52.120	4500.85	4498.59	4493.58	4499.08	4498.28
	52.097	4500.92	4498.57	4493.54	4499.04	4498.27
	52.093	4500.08	4498.31	4492.88	4498.38	4498.33
	52.086	4500.08	4498.31	4492.88	4498.38	4498.33
	52.078	4499.48	4495.44	4492.59	4498.09	4495.87
	52.072	4499.63	4495.42	4492.49	4497.99	4495.75
	52.044	4499.47	4495.4	4492.27	4497.77	4495.7
	52.021	4499.35	4495.37	4492.03	4497.53	4495.63

Description	Station (miles)	River		Landmark Bridges Alternative C2 (Removal of Sierra, Lake and Virginia St. Bridges)	Landmark Bridges Alternative C2 w/ 5.5' of R&U (Removal of Sierra, Lake and Virginia St. Bridges)	Rehab -New Span Alternative A4 (Plazas to 1st St./no Br. Replacement)
		Widening Alternative D w/ 6.6' of R&U (Minimum Floodwall Height)	No Action Alternative (Existing Conditions)			
Center	52.000	4499.09	4495.14	4491.8	4497.3	4495.55
	51.995	4499.09	4495.14	4491.8	4497.3	4495.55
Lake	51.990	4498.51	4494.2	4491.07	4496.57	4494.65
	51.945	4498.18	4494.13	4490.58	4496.08	4494.5
	51.920	4498.24	4494.08	4490.34	4495.84	4494.48
	51.915	4498.24	4494.08	4490.34	4495.84	4494.48
	51.910	4496.37	4490.27	4490.27	4495.77	4490.27
	51.895	4495.81	4489.74	4489.74	4495.24	4489.74
	51.880	4495.53	4489.18	4489.18	4494.68	4489.18
	51.850	4495.76	4488.63	4488.63	4494.13	4488.63
	51.810	4495.44	4488.33	4488.33	4493.83	4488.33
	51.770	4494.68	4488.08	4488.08	4493.58	4488.08
East 2nd	51.730	4491.79	4485.19	4485.19	4490.69	4485.19
	51.725	4491.79	4485.19	4485.19	4490.69	4485.19
	51.720	4490.44	4483.84	4483.84	4489.34	4483.84
	51.710	4489.77	4483.17	4483.17	4488.67	4483.17
Keunzli	51.690	4490.79	4484.19	4484.19	4489.69	4484.19
	51.685	4490.79	4484.19	4484.19	4489.69	4484.19
	51.680	4490.43	4483.83	4483.83	4489.33	4483.83
	51.670	4489.92	4483.32	4483.32	4488.82	4483.32
	51.640	4487.47	4480.87	4480.87	4486.37	4480.87
	51.610	4487.65	4481.05	4481.05	4486.55	4481.05
	51.570	4487.3	4480.7	4480.7	4486.2	4480.7
	51.550	4487.39	4480.79	4480.79	4486.29	4480.79
	51.540	4487.43	4480.83	4480.83	4486.33	4480.83
	51.510	4486.51	4479.91	4479.91	4485.41	4479.91
Wells	51.470	4486.32	4479.72	4479.72	4485.22	4479.72
	51.460	4486.63	4480.03	4480.03	4485.53	4480.03
	51.440	4486.63	4480.03	4480.03	4485.53	4480.03
	51.420	4483.36	4476.76	4476.76	4482.26	4476.76
	51.410	4483.5	4476.9	4476.9	4482.4	4476.9
	51.380	4481.8	4475.2	4475.2	4480.7	4475.2
	51.340	4480.9	4474.3	4474.3	4479.8	4474.3
	51.310	4479.67	4473.07	4473.07	4478.57	4473.07
	51.270	4479.52	4472.92	4472.92	4478.42	4472.92
	51.230	4476.2	4469.6	4469.6	4475.1	4469.6
Kirman	51.180	4475.3	4468.7	4468.7	4474.2	4468.7
	51.170	4475.75	4469.15	4469.15	4474.65	4469.15
	51.150	4475.74	4469.14	4469.14	4474.64	4469.14
	51.145	4475.74	4469.14	4469.14	4474.64	4469.14
	51.139	4475.55	4468.95	4468.95	4474.45	4468.95
	51.130	4475.47	4468.87	4468.87	4474.37	4468.87
	51.080	4473.74	4467.14	4467.14	4472.64	4467.14
	51.070	4470.52	4463.92	4463.92	4469.42	4463.92
	51.040	4468.5	4461.9	4461.9	4467.4	4461.9
	51.000	4467.37	4460.77	4460.77	4466.27	4460.77
	50.960	4466.73	4460.13	4460.13	4465.63	4460.13

Description	River Station (miles)					
		Widening Alternative D w/ 6.6' of R&U (Minimum Floodwall Height)	No Action Alternative (Existing Conditions)	Landmark Bridges Alternative C2 (Removal of Sierra, Lake and Virginia St. Bridges)	Landmark Bridges Alternative C2 w/ 5.5' of R&U (Removal of Sierra, Lake and Virginia St. Bridges)	Rehab -New Span Alternative A4 (Plazas to 1st St./no Br. Replacement)
Kietzke HWY 395	50.920	4466.73	4460.13	4460.13	4465.63	4460.13
	50.910	4465.63	4459.03	4459.03	4464.53	4459.03
	50.880	4462.93	4456.33	4456.33	4461.83	4456.33
	50.840	4463.07	4456.47	4456.47	4461.97	4456.47
	50.830	4462.82	4456.22	4456.22	4461.72	4456.22
	50.810	4462.81	4456.21	4456.21	4461.71	4456.21
	50.770	4462.9	4456.3	4456.3	4461.8	4456.3
	50.720	4460.82	4454.22	4454.22	4459.72	4454.22
	50.690	4460.59	4453.99	4453.99	4459.49	4453.99
	50.660	4459.21	4452.61	4452.61	4458.11	4452.61
	50.650	4459.44	4452.84	4452.84	4458.34	4452.84
	50.640	4459.44	4452.84	4452.84	4458.34	4452.84
	50.630	4457.83	4451.23	4451.23	4456.73	4451.23
	50.565	4456.62	4450.03	4450.03	4455.53	4450.03
	50.537					
	50.48					
	50.381					
	50.253					
	50.124					
	50.048					
	50.01					
Glendale Ave	49.9985					
	49.987					
	49.959					
	49.891					
	49.794					
	49.713					
	49.635					
	49.529					
	49.497					
	49.436					
Greg Street	49.43225					
	49.4285					
	49.44					
	49.355					
	49.258					
	49.165					
	49.131					
	49.05					
	48.957					
	48.887					
Rock Blvd	48.838					
	48.8305					
	48.823					
	48.747					
	48.698					

Description	River Station (miles)					
		Widening Alternative D w/ 6.6' of R&U (Minimum Floodwall Height)	No Action Alternative (Existing Conditions)	Landmark Bridges Alternative C2 (Removal of Sierra, Lake and Virginia St. Bridges)	Landmark Bridges Alternative C2 w/ 5.5' of R&U (Removal of Sierra, Lake and Virginia St. Bridges)	Rehab -New Span Alternative A4 (Plazas to 1st St./no Br. Replacement)
McCarran EOM	48.584					
	48.47					
	48.364					
	48.209					
	48.105					
	47.986					
	47.79					
	47.671					
	47.622					
	47.6135					
	47.605					
	47.477					
	47.414					
Sparks City Limit Steamboat WTP	47.2					
	47.0					
	46.8					
	46.6					
	46.4					
	46.2					
	46.0					
	45.8					
	45.6					
	45.4					
	45.2					
	45.0					
	44.8					
	44.6					
	44.4					
	44.2					
	44.0					

Truckee River
Comparison of High
(All Values 1988 Datum)

Description	River Station (miles)				Montgomery Watson Baseline HEC-RAS (U/S 395)	
		Rehab -New Span Alternative A4 w/ 4.1' of R&U (Plazas to 1st St./no Br. Replacement)	Rehabilitation Alternative A3 (No Br. Replacement/N o Widening)	Rehabilitation Alternative A3 w/ 4.3' of R&U (No Br. Replacement/N o Widening)	Alt A,B&D Left Bank Station Elevation	Alt A,B&D Right Bank Station Elevation
Booth Street	53.420	4528.23	4524.13	4528.43	4526.7	4527.4
	53.100	4521.31	4516.64	4520.94	4515.4	4516.5
	52.940	4520.62	4515.68	4519.98	4508.5	4517.5
	52.930	4520.75	4514.72	4519.02	4502.9	4499.38
	52.925	4520.75	4514.72	4519.02	4502.9	4499.38
	52.920	4517.15	4511.63	4515.93	4502.9	4499.38
	52.900	4515.44	4511.29	4515.59	4510.75	4533.5
Keystone	52.860	4514.7	4510.55	4514.85	4509.67	4521.9
	52.820	4513.95	4509.83	4514.13	4508.37	4520.9
	52.815	4513.95	4509.83	4514.13	4508.37	4520.9
	52.810	4512.91	4508.84	4513.14	4505.6	4516.5
	52.760	4511.98	4507.96	4512.26	4504	4513.5
	52.720	4511.5	4507.49	4511.79	4505.73	4514.3
	52.670	4510.18	4506.33	4510.63	4505.5	4513.5
	52.630	4507.45	4503.37	4507.67	4505.17	4513.5
	52.600	4507.53	4503.62	4507.92	4504.65	4513.5
	52.580	4507.61	4503.83	4508.13	4503	4513
N Arlington S Arlington	52.560	4507.42	4503.53	4507.83	4504.39	4513.5
	52.520	4507.23	4503.31	4507.61	4504.96	4498.5
	52.436	4507.31	4503.32	4507.62	4502.55	4497.94
	52.380	4507.21	4503.37	4507.67	4502.46	4498.7
	52.335	4507.31	4503.42	4507.72	4499.9	4497.9
	52.326	4507.28	4503.39	4507.69	4500.2	4495.5
	52.317	4507.11	4503.24	4507.54	4501	4498.4
	52.309	4507.11	4503.24	4507.54	4501	4498.4
	52.309	4507.11	4503.24	4507.54	4501	4498.4
	52.301	4506.37	4502.62	4506.92	4501.32	4498.4
Sierra	52.292	4506.37	4502.65	4506.95	4500.58	4499.5
	52.210	4506.1	4502.52	4506.82	4493.1	4498.3
	52.180	4505.38	4502.04	4506.34	4495.5	4494.3
	52.167	4505	4501.62	4505.92	4498.16	4494.15
	52.159	4505.09	4501.63	4505.93	4496.39	4496.32
	52.154	4505.09	4501.63	4505.93	4496.39	4496.32
	52.148	4502.75	4499.05	4503.35	4497.35	4496.96
Virginia	52.142	4502.43	4499.15	4503.45	4497.86	4500.6
	52.120	4502.38	4499.25	4503.55	4496.21	4500.8
	52.097	4502.37	4499.29	4503.59	4497.57	4497.9
	52.093	4502.43	4498.97	4503.27	4497.3	4496.5
	52.086	4502.43	4498.97	4503.27	4497.3	4496.5
	52.078	4499.97	4495.89	4500.19	4497.01	4497.01
	52.072	4499.85	4495.89	4500.19	4496.5	4498.07
	52.044	4499.8	4495.82	4500.12	4494.65	4496.75
	52.021	4499.73	4495.75	4500.05	4493.36	4495.5

Description	River Station (miles)	Montgomery Watson Baseline HEC-RAS (U/S 395)				
		Rehab -New Span Alternative A4 w/ 4.1' of R&U (Plazas to 1st St./no Br. Replacement)	Rehabilitation Alternative A3 (No Br. Replacement/N o Widening)	Rehabilitation Alternative A3 w/ 4.3' of R&U (No Br. Replacement/N o Widening)	Alt A,B&D Left Bank Station Elevation	Alt A,B&D Right Bank Station Elevation
Center	52.000	4499.65	4495.67	4499.97	4494.08	4494.5
	51.995	4499.65	4495.67	4499.97	4494.08	4494.5
	51.990	4498.75	4494.65	4498.95	4494.5	4494.5
	51.945	4498.6	4494.5	4498.8	4491	4492.25
	51.920	4498.58	4494.48	4498.78	4491.28	4491
Lake	51.915	4498.58	4494.48	4498.78	4491.28	4491
	51.910	4494.37	4490.27	4494.57	4490.7	4491.7
	51.895	4493.84	4489.74	4494.04	4489.6	4491.1
	51.880	4493.28	4489.18	4493.48	4488.5	4490.5
	51.850	4492.73	4488.63	4492.93	4490.5	4491.5
East 2nd	51.810	4492.43	4488.33	4492.63	4490.9	4491.04
	51.770	4492.18	4488.08	4492.38	4488.5	4488.5
	51.730	4489.29	4485.19	4489.49	4496.22	4492.8
	51.725	4489.29	4485.19	4489.49	4496.22	4492.8
	51.720	4487.94	4483.84	4488.14	4493	4492.5
Keunzli	51.710	4487.27	4483.17	4487.47	4489.5	4488.36
	51.690	4488.29	4484.19	4488.49	4497.27	4497.27
	51.685	4488.29	4484.19	4488.49	4497.27	4497.27
	51.680	4487.93	4483.83	4488.13	4497.8	4498.5
	51.670	4487.42	4483.32	4487.62	4484.33	4483.5
Wells	51.640	4484.97	4480.87	4485.17	4482.12	4478.5
	51.610	4485.15	4481.05	4485.35	4481.63	4483.44
	51.570	4484.8	4480.7	4485	4479.7	4484.8
	51.550	4484.89	4480.79	4485.09	4483.6	4481.2
	51.540	4484.93	4480.83	4485.13	4483.5	4483.4
Kirman	51.510	4484.01	4479.91	4484.21	4485.1	4484.3
	51.470	4483.82	4479.72	4484.02	4480.8	4479.5
	51.460	4484.13	4480.03	4484.33	4483.8	4482.4
	51.440	4484.13	4480.03	4484.33	4483.8	4482.4
	51.420	4480.86	4476.76	4481.06	4476	4477
	51.410	4481	4476.9	4481.2	4478.6	4473.2
	51.380	4479.3	4475.2	4479.5	4486.9	4470.4
	51.340	4478.4	4474.3	4478.6	4477.2	4472.9
	51.310	4477.17	4473.07	4477.37	4471.3	4471.9
	51.270	4477.02	4472.92	4477.22	4473.5	4478.5
	51.230	4473.7	4469.6	4473.9	4480.33	4475.06
	51.180	4472.8	4468.7	4473	4470.2	4466
	51.170	4473.25	4469.15	4473.45	4468	4461.9
	51.150	4473.24	4469.14	4473.44	4467.71	4473.5
	51.145	4473.24	4469.14	4473.44	4467.71	4473.5
	51.139	4473.05	4468.95	4473.25	4467.71	4473.5
	51.130	4472.97	4468.87	4473.17	4474.5	4473.5
	51.080	4471.24	4467.14	4471.44	4464.8	4462
	51.070	4468.02	4463.92	4468.22	4465.6	4470.6
	51.040	4466	4461.9	4466.2	4469.5	4470.12
	51.000	4464.87	4460.77	4465.07	4465.5	4468.35
	50.960	4464.23	4460.13	4464.43	4475.5	4464.5

Description	River Station (miles)	Montgomery Watson Baseline HEC-RAS (U/S 395)				
		Rehab -New Span Alternative A4 w/ 4.1' of R&U (Plazas to 1st St./no Br. Replacement)	Rehabilitation Alternative A3 (No Br. Replacement/N o Widening)	Rehabilitation Alternative A3 w/ 4.3' of R&U (No Br. Replacement/N o Widening)	Alt A,B&D Left Bank Station Elevation	Alt A,B&D Right Bank Station Elevation
Kietzke HWY 395	50.920	4464.23	4460.13	4464.43	4476.5	4458.5
	50.910	4463.13	4459.03	4463.33	4475.84	4456.5
	50.880	4460.43	4456.33	4460.63	4475.5	4458.5
	50.840	4460.57	4456.47	4460.77	4469.5	4459.5
	50.830	4460.32	4456.22	4460.52	4455.3	4456.4
	50.810	4460.31	4456.21	4460.51	4474.5	4458.5
	50.770	4460.4	4456.3	4460.6	4473.5	4458
	50.720	4458.32	4454.22	4458.52	4469.5	4456
	50.690	4458.09	4453.99	4458.29	4464.5	4461.42
	50.660	4456.71	4452.61	4456.91	4459.5	4462.51
	50.650	4456.94	4452.84	4457.14	4448.3	4449
	50.640	4456.94	4452.84	4457.14	4448.3	4449
	50.630	4455.33	4451.23	4455.53	4448.3	4449
	50.565	4454.13	4450.03	4454.33	4453.5	4451.5
Glendale Ave	50.537					
	50.48					
	50.381					
	50.253					
	50.124					
	50.048					
	50.01					
	49.9985					
	49.987					
	49.959					
	49.891					
	49.794					
	49.713					
	49.635					
Greg Street	49.529					
	49.497					
	49.436					
	49.43225					
	49.4285					
	49.44					
	49.355					
	49.258					
	49.165					
	49.131					
	49.05					
	48.957					
	48.887					
	48.838					
Rock Blvd	48.8305					
	48.823					
	48.747					
	48.698					

Description	River Station (miles)	Rehab -New Span Alternative A4 w/ 4.1' of R&U (Plazas to 1st St./no Br. Replacement)	Rehabilitation Alternative A3 (No Br. Replacement/N o Widening)	Rehabilitation Alternative A3 w/ 4.3' of R&U (No Br. Replacement/N o Widening)	Montgomery Watson Baseline HEC-RAS (U/S 395)	
					Alt A,B&D Left Bank Station Elevation	Alt A,B&D Right Bank Station Elevation
McCarran EOM	48.584					
	48.47					
	48.364					
	48.209					
	48.105					
	47.986					
	47.79					
	47.671					
	47.622					
	47.6135					
	47.605					
	47.477					
	47.414					
Sparks City Limit Steamboat WTP	47.2					
	47.0					
	46.8					
	46.6					
	46.4					
	46.2					
	46.0					
	45.8					
	45.6					
	45.4					
	45.2					
	45.0					
	44.8					
	44.6					
	44.4					
	44.2					
	44.0					

Truckee River
Comparison of High
 (All Values 1988 Datum)

Description	River Station (miles)				
		Alt C Left Bank Station Elevation	Alt C Right Bank Station Elevation	Alt A4 Left Bank Station Elevation	Alt A4 Right Bank Station Elevation
Booth Street	53.420	4526.7	4527.4	4526.7	4527.4
	53.100	4515.4	4516.5	4515.4	4516.5
	52.940	4508.5	4517.5	4511.25	4517.5
	52.930	4502.9	4499.38	4511.94	4517.59
	52.925	4502.9	4499.38	4511.94	4517.59
	52.920	4502.9	4499.38	4511.64	4517.59
	52.900	4510.75	4533.5	4510.75	4533.5
	52.860	4509.67	4521.9	4509.67	4521.9
Keystone	52.820	4508.37	4520.9	4508.37	4520.9
	52.815	4508.37	4520.9	4508.37	4520.9
	52.810	4505.6	4516.5	4505.6	4516.5
	52.760	4504	4513.5	4506	4513.5
	52.720	4505.73	4514.3	4505.73	4514.3
	52.670	4505.5	4513.5	4505.5	4513.5
	52.630	4505.17	4513.5	4505.17	4513.5
	52.600	4504.65	4513.5	4504.65	4513.5
N Arlington S Arlington	52.580	4503	4513	4503	4513
	52.560	4504.39	4513.5	4504.39	4513.5
	52.520	4504.96	4498.5	4504.96	4498.5
	52.436	4502.55	4497.94	4502.55	4497.94
	52.380	4502.46	4498.7	4502.46	4498.7
	52.335	4499.9	4497.9	4499.9	4497.9
	52.326	4500.2	4495.5	4500.2	4495.5
	52.317	4501	4498.4	4501	4502
Sierra	52.309	4501	4498.4	4501	4502
	52.309	4501	4498.4	4501	4502
	52.301	4501.32	4498.4	4501.32	4498.4
	52.292	4500.58	4499.5	4500.58	4499.5
	52.210	4493.1	4498.3	4494.7	4498.3
	52.180	4495.5	4494.3	4495.5	4494.3
	52.167	4498.16	4493.9	4498.16	4493.9
	52.159	4496.39	4496.39	4496.39	4496.39
Virginia	52.154	4496.39	4496.39	4496.39	4496.39
	52.148	4496.96	4496.96	4498.81	4496.96
	52.142	4494.86	4500.6	4498.7	4500.6
	52.120	4496.21	4500.8	4498.49	4500.8
	52.097	4497.57	4501	4498.22	4501
	52.093	4497.3	4496.5	4497.3	4496.5
	52.086	4497.3	4496.5	4497.3	4496.5
	52.078	4497.01	4497.01	4497.01	4497.01
	52.072	4496	4498	4497.38	4498
	52.044	4494.3	4496.75	4495.99	4496.75
	52.021	4492.66	4495.5	4494.23	4495.5

Description	River Station (miles)				
		Alt C Left Bank Station Elevation	Alt C Right Bank Station Elevation	Alt A4 Left Bank Station Elevation	Alt A4 Right Bank Station Elevation
Center	52.000	4494.08	4494.5	4494.08	4494.5
	51.995	4494.08	4494.5	4494.08	4494.5
	51.990	4494.5	4494.5	4494.5	4494.5
	51.945	4491	4492.25	4491	4492.25
	51.920	4491.28	4491	4491.28	4491
Lake	51.915	4491.28	4491	4491.28	4491
	51.910	4490.7	4491.7	4490.7	4491.7
	51.895	4489.6	4491.1	4489.6	4491.1
	51.880	4488.5	4490.5	4488.5	4490.5
	51.850	4490.5	4491.5	4490.5	4491.5
East 2nd	51.810	4490.9	4491.04	4490.9	4491.04
	51.770	4488.5	4488.5	4488.5	4488.5
	51.730	4496.22	4492.8	4496.22	4492.8
	51.725	4496.22	4492.8	4496.22	4492.8
	51.720	4493	4492.5	4493	4492.5
Keunzli	51.710	4489.5	4488.36	4489.5	4488.36
	51.690	4497.27	4497.27	4497.27	4497.27
	51.685	4497.27	4497.27	4497.27	4497.27
	51.680	4497.8	4498.5	4497.8	4498.5
	51.670	4484.33	4483.5	4484.33	4483.5
Wells	51.640	4482.12	4478.5	4482.12	4478.5
	51.610	4481.63	4483.44	4481.63	4483.44
	51.570	4479.7	4484.8	4479.7	4484.8
	51.550	4483.6	4481.2	4483.6	4481.2
	51.540	4483.5	4483.4	4483.5	4483.4
Kirman	51.510	4485.1	4484.3	4485.1	4484.3
	51.470	4480.8	4479.5	4480.8	4479.5
	51.460	4483.8	4482.4	4483.8	4482.4
	51.440	4483.8	4482.4	4483.8	4482.4
	51.420	4476	4477	4476	4477
	51.410	4478.6	4473.2	4478.6	4473.2
	51.380	4486.9	4470.4	4486.9	4470.4
	51.340	4477.2	4472.9	4477.2	4472.9
	51.310	4471.3	4471.9	4471.3	4471.9
	51.270	4473.5	4478.5	4473.5	4478.5
	51.230	4480.33	4475.06	4480.33	4475.06
	51.180	4470.2	4466	4470.2	4466
	51.170	4468	4461.9	4468	4461.9
	51.150	4467.71	4473.5	4467.71	4473.5
	51.145	4467.71	4473.5	4467.71	4473.5
	51.139	4467.71	4473.5	4467.71	4473.5
	51.130	4474.5	4473.5	4474.5	4473.5
	51.080	4464.8	4462	4464.8	4462
	51.070	4465.6	4470.6	4465.6	4470.6
	51.040	4469.5	4470.12	4469.5	4470.12
	51.000	4465.5	4468.35	4465.5	4468.35
	50.960	4475.5	4464.5	4475.5	4464.5

Description	River Station (miles)			Alt A4 Left Bank Station Elevation	Alt A4 Right Bank Station Elevation
		Alt C Left Bank Station Elevation	Alt C Right Bank Station Elevation		
Kietzke HWY 395	50.920	4476.5	4458.5	4476.5	4458.5
	50.910	4475.84	4456.5	4475.84	4456.5
	50.880	4475.5	4458.5	4475.5	4458.5
	50.840	4469.5	4459.5	4469.5	4459.5
	50.830	4455.3	4456.4	4455.3	4456.4
	50.810	4474.5	4458.5	4474.5	4458.5
	50.770	4473.5	4458	4473.5	4458
	50.720	4469.5	4456	4469.5	4456
	50.690	4464.5	4461.42	4464.5	4461.42
	50.660	4459.5	4462.51	4459.5	4462.51
	50.650	4448.3	4449	4448.3	4449
	50.640	4448.3	4449	4448.3	4449
	50.630	4448.3	4449	4448.3	4449
	50.565	4453.5	4451.5	4453.5	4451.5
	50.565				
Glendale Ave	50.537				
	50.48				
	50.381				
	50.253				
	50.124				
	50.048				
	50.01				
	49.9985				
	49.987				
	49.959				
	49.891				
	49.794				
	49.713				
	49.635				
	49.529				
Greg Street	49.497				
	49.436				
	49.43225				
	49.4285				
	49.44				
	49.355				
	49.258				
	49.165				
	49.131				
	49.05				
	48.957				
	48.887				
	48.838				
	48.8305				
	48.823				
Rock Blvd	48.747				
	48.698				

Description	River Station (miles)				
		Alt C Left Bank Station Elevation	Alt C Right Bank Station Elevation	Alt A4 Left Bank Station Elevation	Alt A4 Right Bank Station Elevation
McCarran EOM	48.584				
	48.47				
	48.364				
	48.209				
	48.105				
	47.986				
	47.79				
	47.671				
	47.622				
	47.6135				
	47.605				
	47.477				
	47.414				
Sparks City Limit Steamboat WTP	47.2				
	47.0				
	46.8				
	46.6				
	46.4				
	46.2				
	46.0				
	45.8				
	45.6				
	45.4				
	45.2				
	45.0				
	44.8				
	44.6				
	44.4				
	44.2				
	44.0				